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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

APRIL 14.

Institute of Metals (London Local Section):—Annual general meeting and open discussion.

APRIL 19.

Institution of Welding Engineers:—Annual general meeting in London. Discussion of "Metallic Arc Welding."

Institute of British Foundrymen.

APRIL 15.

Sheffield and District Branch:—Annual general meeting. "The Spun-Pipe Plant at Staveley Coal & Iron Company," Paper by J. B. Allan.

APRIL 16.

Lancashire Branch (Junior Section):—Annual general meeting. "The Merits of Oil-Bonded Cores," Paper by A. L. Key.

APRIL 21.

London Branch:—Annual general meeting. "Crucible Melting Furnaces," Paper by G. L. Cassidy.

APRIL 23.

Newcastle-upon-Tyne and District Branch:—Annual general meeting, and general discussion on Foundry Problems.

The Session in Retrospect.

The early weeks of April usually see the winter session of the various technical societies drawing to an end and the usual activity enters upon the close season. Considering the retarding effect of a depressed period, for not only does it bring about changes through movements of foundrymen from one centre to another, but it tends to discourage younger men particularly, the session is one giving plenty of cause for congratulation. The Institute of Metals held a very useful discussion on the testing of castings. Practically all the Branches of the Institute of British Foundrymen have had something good to offer, and some have done exceptionally well in the presentation of new matter. Only a harassed Branch secretary knows what it means to get together each winter a balanced programme containing something to attract everybody, and something really new.

An extremely useful Paper was that of Mr. West to the Lancashire Branch, on the shrinkage of low-carbon irons. It recorded in a practical way some experiments to ascertain a perfectly definite series of facts and reached quite definite conclusions. The London Branch had an excellent Paper by Mr. Boon on pulverised fuel, and variety was provided by Mr. Scott on the working of a rotary furnace and by Dr. Vanzetti on Italian practice. We have already referred previously to a remarkably good Paper on moulding-sand practice presented to the Scottish Branch by Mr. Buchanan. We are also glad to note that more than one Branch has had the views of engineers with regard to the foundry. Sheffield had another of Mr. Hurst's useful Papers, this time on heat-treated cast irons. Taking everything into consideration, for general variety and novelty, in a brief review which excludes for the moment Papers on non-ferrous alloys and also Papers presented to joint meetings, we think the Birmingham and Coventry Branch takes the palm this session. All the Papers were good and novel. One was on malleable iron, one on automobile cast-iron developments, by Mr. Twigger, one on sand-blast plant, and one, by Mr. Bradshaw, on enamelling, a subject only too scantily treated in technical literature. At another meeting an admirable series of short Papers was presented. The East Midlands Branch made a commendable effort to introduce continuity in a series of Papers which was intended to cover the manufacture of high-duty iron from the smelting of the ore, whilst noting all along potential influences on the finished article. All these Papers need a close season for their proper digestion.

Is Trade Improving?

We are incurably optimistic, although at times, especially during the dark days of last autumn, we were in some doubt as to whether or not our optimism was justified. To-day we feel confident that it was. Now that Easter is over, and with it the usual slacking-off which always precedes a holiday, we can take stock of ourselves and see what crumbs of comfort we can gather from a study of our industry and of our country.

So far as Great Britain is concerned, she is undoubtedly in a better condition as regards trade than any other country in the world. Her budget is balanced, in fact a surplus is indicated, whilst many of the leading nations are faced with a deficit. Solvency, as every business man knows, is the first essential of a successful business, and still more so of a premier nation. The fact that the budget *was* balanced speaks volumes for the characteristics of our nationals. A people who can overcome such an appalling state of affairs as we were faced with last September uncomplainingly and without apparent effort must succeed by sheer integrity if nothing else. There was a time when every other industrial nation but our own was said to be forging ahead whilst we remained antiquated and tradition-bound. An examination of other countries to-day will reveal the fact that their apparent prosperity was based largely on artificial conditions (due to a great extent to the war) which, tried by the fire of adversity, proved to be inadequate foundations. We, on the other hand, while suffering from diminished trade, stand firmly on our own legs; solvent, confident, and, by comparison with other countries, prosperous.

Turning to the foundry industry, we find many reasons for optimism. We know that we are busier than our contemporaries in any other country—and should remain so. Owing to the imposition of tariffs and our deflection from the gold standard we have almost daily evidence of foreign firms building works in this country—in some cases actually foundries—for the production of goods which were imported as finished articles hitherto. We hear of large orders being placed for repetition castings which were formerly made abroad and exported to us. We learn of blast furnaces being recommissioned and of large engineering development schemes about to be launched. All this means work for our foundries not only in the future but now. As

to the industry's ability to cope with modern conditions we have no fear. The slur of antiquity cannot fairly be levelled at the foundry industry to-day. Within the last few years modernisation has been carried out to such an extent that nowadays it is no uncommon thing to find a highly-organised and splendidly-equipped foundry in the heart of rural England. Our heritage is great, our prestige is high, our ideas are modern—let us go forward with calm confidence into that era of prosperity which is dawning.

Notes from I.B.F. Branches.

West Yorkshire.—Members of the West Yorkshire Branch of the Institute of British Foundrymen paid a visit recently to the Central Ironworks, Huddersfield, of Messrs. Thos. Broadbent & Sons, Limited, by kind invitation of the directors. The party, under the leadership of the Branch-President, Mr. A. S. Worcester, were met at the works by Mr. H. G. Cran, director, and Mr. George T. Broadbent, publicity manager, and were divided into groups for the tour of the works under the guidance of departmental heads and others of the staff. The party numbered about 60.

The tour began in the hydro- and centrifugal-pump department, and proceeded from there through the constructional department, the erecting shops, the heavy machine shop; the turning shops; the pattern shop and finally the foundry for small castings and the heavy iron foundry and the cupola stages, etc. Work was seen in progress on hydro extractors and other centrifugal equipment in which Messrs. Broadbent are specialists; and the visitors were especially interested in a big order for a special testing equipment for the Admiralty, an order almost completed and occupying the space of over half the main erecting shop; and also in a large transporter for moving 100-ton railway engines bodily from one line to another.

After the visit the party were entertained by the firm to tea in the works canteen, where Mr. Cran presided, and the firm, the directors and members of the staff who had assisted were heartily thanked by the gathering, on the proposition of the Branch-President, seconded by Mr. W. G. Thornton and supported by Mr. S. W. Wise (hon. secretary). Mr. Worcester remarked that Messrs. Broadbent and their foundry manager had every reason to be congratulated on the castings they produced and on those seen that afternoon. It had been a very real education for the members to see the whole of the processes of making the famous Broadbent specialities from start to finish.

Mr. Wise said the members of the foundry industry had reason to be grateful to Messrs. Broadbent not only for an instructional visit and warm hospitality, but also for the firm's ready support to the Institution's craft certificate scheme for the education of young foundrymen. The scheme had been taken up well in the Huddersfield district and two successful classes were being conducted there. Messrs. Broadbent were believers in the scheme and had gone to the trouble of inviting the students of the classes to join that day's gathering. It was their misfortune, but not their fault, that the message had not reached the young men in time for them to take advantage of the opportunity.

Mr. Cran, replying on behalf of the firm, regretted the unavoidable absence of his co-directors. The visitors that day had, one might say, seen both sides of the picture as between the foundryman and the engineer. They had seen the engineering side, which, of course, always insisted that it was struggling with bad castings, and they had seen the foundry, in which everybody employed there maintained they were turning out the best castings in the world. Undoubtedly, the foundry side was a most important part of the engineering business. Without good tools one could not produce good engineering, and without good castings one could not turn out a satisfactory finished article.

Lancashire.—The annual meeting of the Lancashire Branch of the Institute was held on April 2 in the Manchester College of Technology. At the opening of the proceedings Mr. Roy Stubbs presided. He remarked that the attendance was much better than is usual at annual meetings, and congratulated the members on having enjoyed a very good programme during the year.

In moving a vote of thanks to the Branch-President and other retiring officers, Mr. R. A. Miles said much of the success of the Branch was due to the energy with which Mr. Stubbs carried out his duties and his personal touch with the details of the work. Mr. J. E. Cooke (secretary) seconded the vote of thanks. He wished to pay tribute to the services of Mr. Stubbs to both the Branch and the Institute. They made a great demand upon his time and patience. The vote of thanks was passed unanimously.

Mr. Stubbs replied that it had not been a one-man job, for he was backed up by an admirable Branch Council. Especially he wished to acknowledge their debt to Mr. Cooke. No Branch in the Institute had a better secretary.

The statement of accounts showed that during the year the subscriptions received were £524 2s., and £29 18s. 6d. was paid direct to the General Secretary. The Branch receipts included £99 10s. remitted by the General Secretary, bank interest 14s. 2d., balance brought forward £58 13s. 6d. Expenses were £120 19s. 2d. and £37 18s. 6d. was carried forward.

The secretary's report stated that during the year there had been a net increase of 61 in the membership, which was now constituted as follows:—Subscribing firms, 12; representatives of subscribing firms, 10; members, 92; associate members, 236; associates, 16; hon. member 1 and life members, 4. There had been a substantial reduction in the arrears of subscriptions. The Burnley Section had maintained its activity and had 47 members. The Preston Section had 79 members. It appeared that the maximum membership in the Lancashire area had not yet been reached.

Mr. Stubbs is succeeded by Mr. E. Flower as President for the coming year, and he expressed the hope that Mr. Flower would carry on the traditions of the Branch and that under his Presidency it would increase its activities and its membership. The new Branch-President assured the members he would spare no effort to prove that their confidence was not misplaced. It was a hard task, because he followed the greatest President the Lancashire Branch had had.

Mr. A. Phillips was elected Senior Vice-President. There were five nominations for the office of Junior Vice-President, and Mr. W. N. Cooke was chosen. Mr. J. E. Cooke was elected honorary secretary. Mr. J. S. G. Primrose and Mr. E. Longden were elected to the Technical Committee. Of the ten nominations made for three vacancies on the Branch Council, Messrs. F. C. Demaine, W. Holland and W. West were elected. Seven vacancies in the list of representatives to the General Council were filled by Messrs. R. W. Stubbs, H. V. Grundy, W. Gilpin, J. Masters, R. A. Miles, J. S. G. Primrose and J. Hogg.

A Paper on "General Rotary Furnace Practice," by Mr. W. Scott (foundry manager) and Mr. S. E. Dawson (chief metallurgist), of Sir W. G. Armstrong Whitworth & Company (Ironfounders), Limited, Gateshead-on-Tyne, was then presented.

Random Shots.

"Marksman" is very often sadly conscious of his lack of general knowledge about the foundry industry. If you were to ask him, for instance, the name of the foundry in Warwickshire which was started up in 1834 by Sir Reginald Fortescue and now employs thirteen moulders and fourteen costing clerks, he would have to confess himself stumped for an answer. Again, if you were to ask how long, when placed end to end, would be all the tensile test-bars broken in Great Britain during a year, all that "Marksman" could say would be: "A dickens of a long way." This ignorance of his often makes him quite melancholy.

* * *

Another thing that "Marksman" doesn't really know (do any of his readers?) is the record number of people taking part in any one works visit. He imagines that the palm must surely go to Messrs. Gillett & Johnston's famous bell foundry at Croydon, which was invaded during the week-end by some 3,000 bellringers. It would have been interesting to have "gate-crashed" during their visit. For one thing, but few founders are acquainted with bell-founding practice; for another, there cannot be more than three or four bell foundries existing in the country to-day. "Marksman" can attribute this paucity to one cause only, and that is the superb craftsmanship of the bell founders of earlier days. It is difficult to appraise their work too highly. Happily we can honour the present just as much as the past, for the bell founders of to-day are contributing to that splendid tradition bequeathed to British bell founding by their forerunners. They have "Marksman's" well wishes.

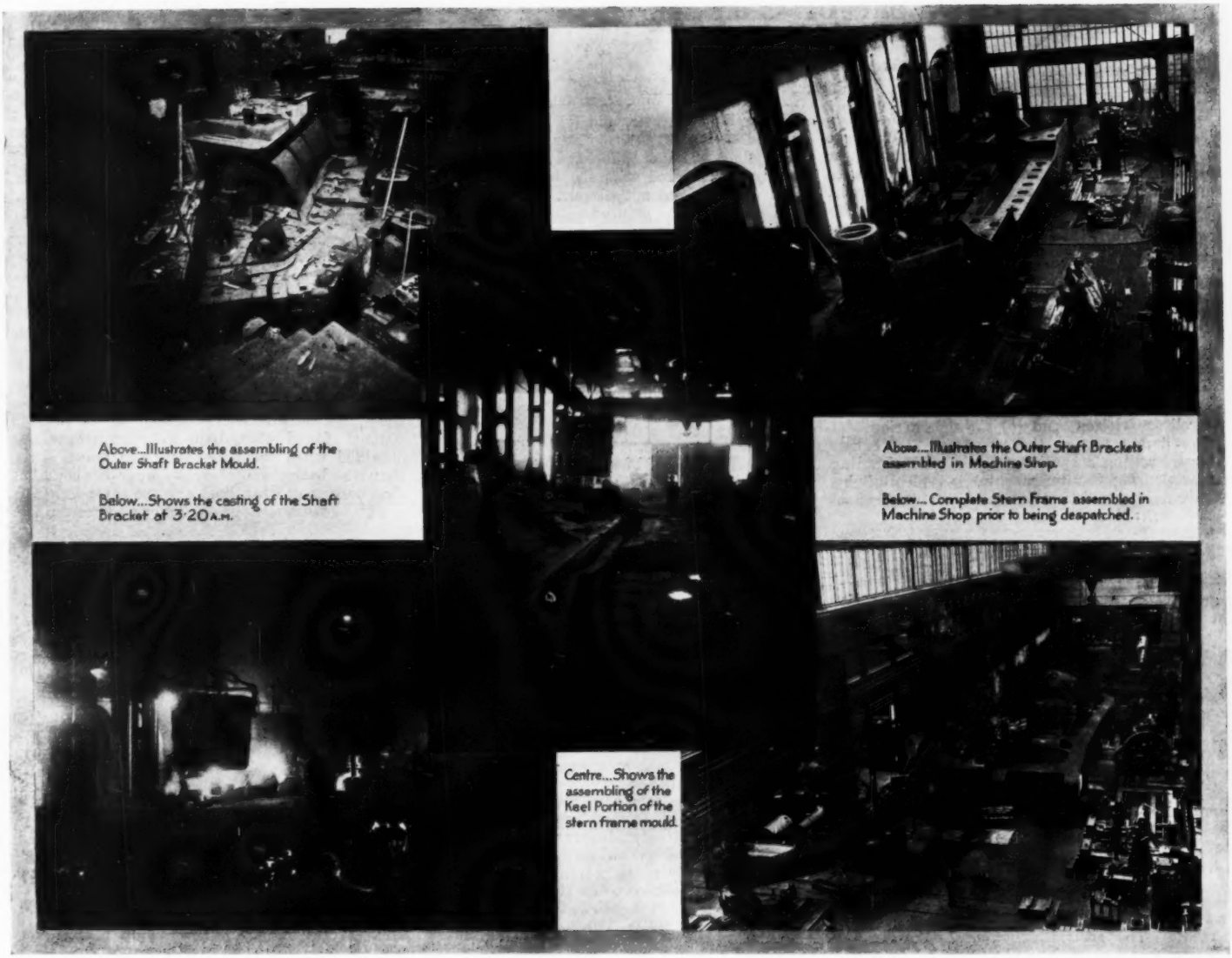
* * *

As a little personal interlude, "Marksman" confesses that bells have always been a matter of keen interest to him. In his younger days, when he could leg the best part of a mile with astonishing celerity, he not uncommonly picked upon the street-door variety as the subject of tentative experiment. Alarm clocks and the telephone have caused him somewhat to modify this ardent manifestation of his interest, but he still agrees with what Dr. Arnold, of Rugby, said to Lewis Carroll on the eve of the Winchester Ball—"Bells were made to be rung." Omnibus drivers cannot dispute the fact. Waitresses ignore it.

* * *

Over the week-end "Marksman" spent a pleasant evening with that magnificent satire on the cinema, Elmer Rice's "Voyage to Purilla." The descriptions of the stock characters of filmland set him wondering what the qualifications of a film critic must be. Directors do not, it is commonly said, encourage originality in scenarios. They favour the story with which the public is thoroughly conversant. Rumour has it that one scenario writer lived for years by repeatedly selling one story to different companies both in the United States and on the Continent. The film critic, I imagine, must have a hard time thinking of new things to say about old material.

Marksman.


Above...Illustrates the assembling of the Outer Shaft Bracket Mould.
Below...Shows the casting of the Shaft Bracket at 3·20 A.M.
Above...Illustrates the Outer Shaft Brackets assembled in Machine Shop.
Below... Complete Stern Frame assembled in Machine Shop prior to being despatched.
Centre...Shows the assembling of the Keel Portion of the stern frame mould.

The Manufacture of Large MARINE ENGINEERING CASTINGS.

At a recent meeting of the Middlesbrough Section of the Institute of British Foundrymen, held at the Cleveland Technical Institute under the presidency of Mr. A. G. Harrison, Mr. F. Swift, foundry manager of the Darlington Forge Branch of the English Steel Corporation, described and illustrated the manufacture of the large castings required for incorporation in the new giant Cunarder, the building of which is, unfortunately, being held up for the time being. The castings dealt with included the stern frame, shaft brackets and rudder, which totalled approximately 600 tons.

Mr. Swift showed how the success of the castings depended upon the co-operation of all the staff, and was not, therefore, due to any one man. He first described how the wooden patterns were made, involving highly skilful work. The completed patterns were then consigned to the foundry, and, because of their colossal size, arranged in pits specially excavated by the engineering staff. At this stage the main points for the moulders to determine were:—(1) How should the patterns be moulded; (2) how should the steel be run into the mould and what should be the design of the runner; (3) where was there likely to be a pull and how could it be counteracted; and (4) the positions, size and shape of the feeding heads, which is a very important point to ensure a sound casting.

On the Cunarder castings there were 110 heads, ranging from 12 to 28 in. dia., and when they were taken off there was not a single pinhole under any of them. It was important that there should be no movement in the mould when the steel was put in. The movement of even $\frac{1}{16}$ in. would tend to liberate the joints of the moulds and the steel would run out. Weights were put on to the moulds to resist the pressure of the steel. The weights ranged from 16 to 40 tons each, and altogether 450 tons of weights were used in holding down the job.

A hundred tons of steel were brought up to the moulds at a time in two ladles by overhead cranes. The teemers opened the nozzles and the steel poured into the sand moulds at the rate of 4½ tons a min. from each runner. From 6 to 12 hrs. after the casting the weights were taken off. The operation known as easing occupied from 12 to 36 hrs. The steel cooled and contracted, and next the castings were placed in an oil-fired stove to reduce the grain size of the steel and make it more ductile.

The work of marking-off which followed had to be done on the floor, as there was not a marking-off table large enough for the larger castings.

Mr. Swift dealt with the work of loading and transporting the castings, and said that when the outer-shaft brackets, weighing 180 tons, were fitted into the liner, the centres were within an eighth of an inch. The chairman, on behalf of the members warmly thanked Mr. Swift for his most interesting and instructive lecture.

The Wear of Cast Iron.*

By A. A. Timmins (B.C.I.R.A.).

Quite a large amount of research has been carried out on the wear of cast iron, and yet no definite information has been obtained, for the results are not consistent. This is due to the innumerable factors which influence wear. Any attempt to standardise one set of conditions while another factor is being considered presents many practical difficulties. It must also be borne in mind that the study of wear is not confined to the properties of any one material, as is the case, for instance, in a tensile test, but it is the study of two surfaces rubbing in contact, and the characteristics of each will influence the rate of wear.

Numerous testing machines have been devised by investigators to measure wearing properties. They may be divided roughly into two classes: (*a*) rolling friction, and (*b*) sliding friction.

The first type, as the name implies, causes wear by rolling a specimen against an abrading material. The Saniter machine is typical of this group, and consists essentially of a specimen

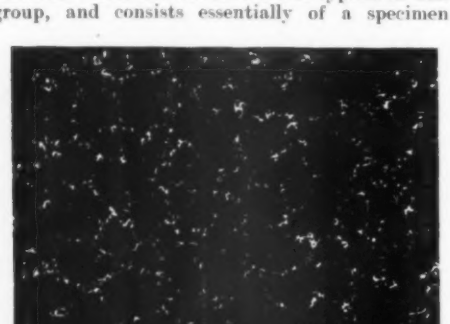


Fig. 1.—Good Network Structure in Grey Cast Iron. × 25 dias.

fitted into a chuck which rotates it against the inside ring of a ball race, which can be suitably loaded. The specimen becomes worn by the friction it sets up with the ball race. The resistance to wear is taken as being inversely proportional to the reduction in diameter of the test-piece after 200,000 revolutions. Sliding friction tests are the most popular, and consist of a loaded test-piece pressed against a rotating plate. In some cases the plate is fixed and the specimen rotated.

In a study of the fundamentals of wear, Swift[1] has rejected the rolling friction type because it introduces complicated factors, such as cold working. He also considers that lubrication tests are impracticable owing to the intermittent nature of the oil film. With perfect lubrication no wear occurs, but in practice the oil film is continually breaking and reforming, and is obviously impossible to control.

From the point of view of the engineer, it seems better either to employ actual service tests or use laboratory tests which embody the same essentials as the service conditions. This, of course, has been done in many cases, and, although individual tests provide little general information on wear, they do allow the development of the best material for the specialised conditions of the test.

Cast Iron as a Wear-Resisting Material.

The superior wear resistance of cast iron is widely known. The explanation of this has been variously attributed to (*a*) lubrication by the graphite flake; (*b*) the bearing metal action of the phosphide eutectic, and (*c*) the formation of a glazed surface.

Hurst[2] in a Paper published in the Carnegie Memoirs, considered that the lubrication action of the graphite did not account for the excellent wear resistance, and pointed out that the presence of the small percentage of graphite on a superficial layer of a cylinder would hardly be sufficient lubricant for the long periods during which such cylinders function successfully. Recent investigations by Klingenstein[3] tend to show that wear is influenced by the distribution and size of graphite flakes. He tested a series of bars of varying thickness and found a slight increase in wear resistance in the thicker bars. This was attributed to the thicker graphite flakes in the larger bars. Tests made by the author have to some extent confirmed this view.

The Rôle of Phosphide Eutectic.

The action of phosphide eutectic on the rate of wear has caused much debate. It is held by some that in good engineering irons the eutectic, being hard, stands out in relief, whilst the softer matrix is worn away—the structure thus being similar to that of a bearing metal. Phosphorus, however, is also considered harmful, and Hurst has published a photograph of a worn liner showing pitting. This he suggests is due to the removal of phosphide eutectic, which forms a grinding paste and so increases the wear.

Tests have been carried out by Lowry[4] using a specimen rotating at 650 r.p.m., braked with a shoe of the same material and loaded by a 15-lb. weight at the end of a 3-ft. lever. The loss in weight by the specimen was taken as a measure of wear, and it was found that increased resistance was achieved by raising the phosphorus content from 0.2 to 0.91 per cent. Piwowarsky, working with a range of 0.1 to 0.75 per cent. phosphorus on an Amsler machine, obtained a similar result. Klingenstein has investigated this problem very thoroughly. Two series of irons were tested—a ferrite series of Brinell hardness below 140 and a phosphorus content of 0.1 to 1.4 per cent., and a pearlitic series of Brinell hardness 240 to 260 and a phosphorus content of 0.35 to 1.9 per cent. He used a brake drum type of test, the specimens being run for 10 min. under a load of 15.24 tons per sq. in. at a speed of 325 r.p.m. His results show that with the ferritic series, which had double the wear of the pearlitic type, increasing the phosphorus content from 0.25 to 0.7 per cent., halved the amount of wear. Further increase in phosphorus had no appreciable effect.

Phosphide Network Structure Desirable.

In the pearlitic series no change in wear took place until 1.3 to 1.4 per cent. phosphorus had been added, and then a 25 per cent. reduction was recorded. It would appear then that benefit could be derived from increased phosphorus content. There is always, however, the accompanying decrease in strength. The phosphorus should be in a good network formation to achieve the best results, as any local segregations will cause unequal wearing of the cast iron. Segregations can also be avoided by keeping the iron near to eutectic composition, thereby shortening the cooling range of the casting. Fig. 1 shows a photo-micrograph of an iron having the phosphide eutectic arranged in a network formation. The matrix has been deeply etched.

Glazed Surfaces.

The question of the glazed surface on cast iron of good wearing properties was first brought to notice by Hurst in 1918. Lehman also mentions it, and attributes it to the material being rubbed off the surface and then filling the cavities so formed. Lowry also observed a hard glass surface when testing a piece of hard iron against a softer one. It was found that the maximum wear of the soft iron occurred after 100 hours' running, but at the end of 1,000 hours it had worn less than the hard piece. The consideration of both of the interacting metals during wear provides an interesting study.

Kühnel[5] published some data in this direction on the service tests of locomotive rings and valve boxes. Actually 650 rings and 48 boxes were tested, and the loss in weight was taken after long intervals. It is interesting to note that greatest failure occurred in the rings when they had a Brinell hardness of below 140. Kühnel found that best wear resistance was obtained when the rings were ten points softer than the boxes, and then the wear is about half that occurring when both are the same hardness.

This, however, is contradictory to results sub-

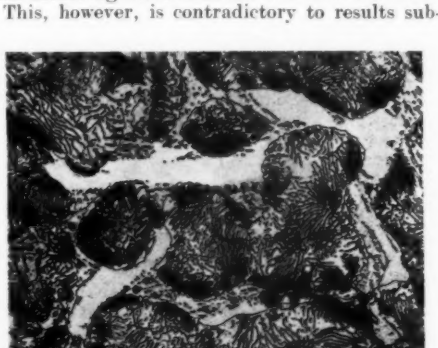


Fig. 2.—Phosphide Eutectic containing Cementite. × 200 dias.

mitted by Klingenstein. He has devised a drill hardness test using a blunt drill 0.4 in. dia. The loss in weight of both drill and plate was taken as representative of wear. Three types of irons were tested having silicon contents of 1.5, 1.8 and 2.4 per cent., and a drill and plate from each iron were tested against each other and also against every other cast. The difference in Brinell hardness is plotted against the amount of wear, and shows that wear is least when the hardness of plate and drill is the same. At the same time the wear is less when the moving part is harder than the fixed part, as compared with the wear when the irons are reversed.

British Practice Confirmed.

This latter point, whilst disproving Kühnel, seems to bear out the view held by many foundrymen in the country—that the piston ring pot and cylinder should be cast from the same ladle—the quicker cooling in the thin piston ring pot giving a slightly harder ring. Various other factors relating to abrasive wear have been investigated. Wear resistance has been found to increase with combined carbon content, which in normal cast irons is a function of the hardness and amount of pearlite.

One might therefore anticipate the influence of alloying elements by their effect on the combined carbon content. It has been shown that silicon decreases wear resistance, whilst carbide-forming elements, such as chromium, increase it by giving a harder matrix. Musatti and Calbiani[6] have performed wear tests on molybdenum cast iron and found decreased wear with

(*Concluded on page* 223.)

* A Paper read before the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, Mr. F. J. Hemming presiding.

BIBLIOGRAPHY.

1 Swift. "Engineering," June 19, 1931, page 783.
2 Hurst. Carnegie Memoirs, 9—59; 1918.
3 Klingenstein. G. H. H. Konzern, "Mitteilungen," 1—18; September, 1930.
4 Lowry. "Iron Age," 119, 1360; May 12, 1927.
5 Kühnel. "Giesserei Zeitung," 24, 538; October 1, 1927.
6 Musatti and Calbiani. "La Metallurgia Italiana"; June, 1930.

Cast Irons with Higher Nickel Additions.

By Dr. A. B. Everest.

(*Continued from page* 196.)

Austenitic Cast Irons.

In 1924* S. E. Dawson published details of a new type of cast iron which he had developed in collaboration with Messrs. Ferranti, Limited. The outstanding feature of this iron was that whilst possessing properties in many respects similar to those of ordinary cast iron it was non-magnetic and accordingly was applicable to a large number of castings in the electrical industry where such a feature was required. The iron, which was manufactured commercially under the name of "Nomag," was also shown to possess an abnormally high electrical resistance.

The special properties of this iron were developed by the use of relatively high proportions of alloy additions, these having the effect of rendering the structure of the iron austenitic. In the last few years a great deal of attention has been given to the subject of alloy cast irons

Fig. 5.—Typical Microstructure of Austenitic Cast Iron. × 500 dias.

generally, and the high-nickel austenitic cast irons have proved of outstanding interest on account of the special characteristics which they show.

The properties of a typical austenitic cast iron may be given as follow: (*a*) Corrosion-resistance, (*b*) heat-resistance, (*c*) non-magnetic,† (*d*) a high coefficient of expansion, (*e*) high electrical resistance,† (*f*) low temperature-coefficient of electrical resistance, (*g*) strengths in some cases as high as for good-quality engineering cast iron,† (*h*) tough under repeated impact, (*j*) ductile as compared with ordinary cast iron (2 per cent. elongation in tensile test), (*k*) hardness down to 100 Brinell,† (*l*) readily machinable, (*m*) easily welded and (*n*) not generally heat-treatable.

It will at once be appreciated that castings showing such properties will have many special applications in engineering practice, and a considerable amount of attention has therefore been devoted to the material so that it may be understood and used to the fullest advantage. Before dealing with the properties of this series of cast irons in detail it will be as well to discuss briefly the influence of composition and the proportions of special elements which are necessary in order to produce the austenitic structure. Early researches, confirmed by more recent practical experience, have shown that a minimum of 20 per cent. of nickel must be added to an ordinary cast-iron base to give an austenitic structure. For practical purposes in this case and also in the following examples it is generally found desirable to increase the amount of austenite-forming elements to 3 or 5 per cent. above the minimum value in order to ensure that the castings are fully austenitic in all sections and under all conditions.

Nickel-Replacing Elements.

For economic reasons and also in order to obtain modifications in the properties of the austenitic irons, part of the nickel is frequently replaced by other elements, within the limits specified below. Thus, part of the nickel is frequently replaced by copper, one part of copper being generally taken as approximately equal to one part of nickel in its tendency to form austenite, but this is only possible up to the limit of 6½ per cent. of copper, since, beyond this percentage, the copper will not alloy under all conditions, and may, therefore, be found undissolved in the castings. On the basis of 20 per cent. of nickel being required to produce austenite, with copper it is, therefore, found that an equivalent alloy is produced with an addition of 13.5 nickel and 6.5 copper.

Manganese may be used to replace part of the nickel, one part of manganese being roughly equivalent to two parts of nickel; but in this case, again, a practical limit is found to the amount of manganese which can be added, this limit being about 5 per cent., above which the presence of manganese carbides impairs the machinability of the castings. Manganese is employed in the development of the non-magnetic cast iron known as "Nomag," already mentioned, the austenitic structure being developed by the addition of 10 per cent. of nickel and 5 per cent. of manganese.

Chromium up to 5 or 6 per cent. may be added to most of the above alloys and confers a certain amount of benefit in improved strength, corrosion and heat-resistance, etc. It is uncertain, however, whether in the presence of the high carbons occurring in the cast irons, chromium materially helps in the production of austenite.

Table I.*—*Comparative Rates of Corrosion.*

Reagent.	Austenitic cast iron.	Ordinary cast iron.	Brass.	Bronze.
5 per cent sulphuric acid cold	1	475.0	1.12	1.08
10 per cent. sulphuric acid at 100 deg. C. ..	1	195.0	0.15	0.15
78 per cent. sulphuric acid at 100 deg. C. ..	1	1.95	—	0.08
5 per cent. hydrochloric acid ..	1	185.0	13.0	24.0
25 per cent. acetic acid	1	400.0	2.75	2.22
Salt spray ..	1	2.9	0.27	0.08
Sea water ..	1	5.0	0.5	2.15

Above about 6 per cent. of chromium in the alloys the structure generally becomes excessively hard and brittle.

It must be remarked that the above limits all apply to combinations of elements which will give a structure which is just in the austentic range. Higher proportions of alloys are frequently used to give castings for special purposes, for example, for specially severe corrosive conditions machinable alloys can be cast which contain up to 40 per cent. of nickel, with about 15 per cent. of chromium.

Properties of the Austenitic Cast Irons.

Corrosion Resistance.

Turning now in greater detail to the cast irons formed by combinations of the alloy additions as discussed above, it is found that the castings are of interest first on account of their corrosion-resisting properties (Fig. 5). In these cast irons the austenitic structures produced by nickel alone show specially good resistance to attack by caustic alkalies and weak sulphuric and hydrochloric acids. The alloys containing copper show similar properties, except that copper is generally considered undesirable when resistance to alkalies is required. On the

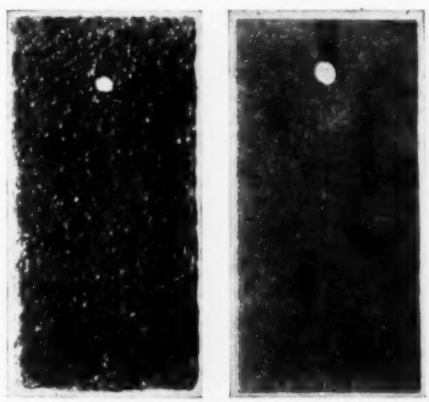


Fig. 6.—Specimens of Ordinary and Austenitic Cast Iron (Right and Left respectively) exposed to Atmosphere of Industrial Town for 1½ Years.

other hand, copper frequently improves the resistance of the alloys to acid attack, such as by weak sulphuric acid.

Among the austenitic cast irons those containing manganese have the poorest all-round corro-

Table II.*—*Corrosion Tests—Weight Loss in Milligrams per Square Decimeter per Day.*

Reagent.	Austenitic cast iron. (1)	Ordinary cast iron. (2)	Ratio (2) : (1)
Atmosphere	Rusts superficially	Rusts badly	—
,, 30 days	9.5	59.7	6
,, 90 days	7.9	63.5	8
,, 1½ years	3.5	35.0	10
Water spray, vertical	6.6	207.5	32
,, horizontal	17.6	244.0	14
Aerated tap water ..	7.8	67.2	9
3 per cent. salt solution	50.0	190.0	4
12½ per cent. fermented molasses solution	10.0	360.0	36
Bad boiler water 95 deg. C.	110.0	660.0	6
Ferric sulphate ..	17,000.0	32,000.0	2
5 per cent. sulphuric acid aerated ..	350.0	30,000.0	85
5 per cent. hydrochloric acid aerated	507.0	26,665.0	50
10 per cent. hydrochloric acid aerated	598	29,475.0	50
20 per cent. hydrochloric acid aerated	1,111.0	33,270.0	30
Hot caustic	30.0	430.0	8

sion-resisting properties and are not suitable where this feature is particularly desired. It is well appreciated, however, that small additions

* "Nomag" Non-Magnetic Cast Iron. S. E. Dawson. Foundry Trade Journal, May 29, 1924.
† These depend on composition.

* M. Ballay, "Recherches sur quelques fontes au nickel et au cuivre," *Revue de Metallurgie*, 1929, XXVI, 538.

* J. S. Vanick and P. D. Merica, "Corrosion and Heat-Resistant Nickel Copper Chromium Cast Iron." *Trans. Amer. Soc. Steel Treating*, 1930, Vol. 18, pp. 923–934.

of chromium to the castings confer very beneficial resistance to most types of corrosive attack.

For corrosion-resisting applications the austenitic cast irons containing nickel, copper and chromium have received most attention. Such irons have been made up under such names as "Nimol," "Ni-Resist," etc., and generally contain 14 or 15 per cent. of nickel, 6 or 7 per cent. of copper and 2 or 4 per cent. of chromium. Tables I and II give the results of corrosion tests carried out on alloys of this type. These tables show unmistakably the advantages possessed by the austenitic irons over ordinary cast iron, especially in contact with weak sulphuric and hydrochloric acids, with acetic acid and other special corrosive media. Smaller advantages, but ones which make the special irons of importance, are shown in contact with sea water, tap water, boiler water, etc. These tables give figures which testify conclusively to the all-round superiority of the alloy cast iron as compared with ordinary cast iron. The results have now been confirmed in a number of industrial applications.

Table I gives an interesting comparison between the special cast iron and brass and

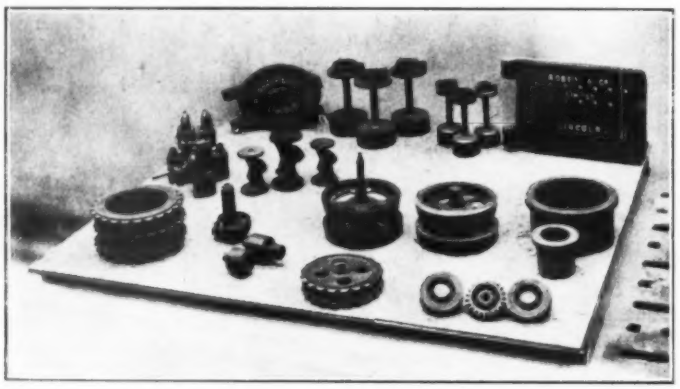


Fig. 7.—Castings in Austenitic Cast Iron, representing Heat- and Corrosion-Resistant Applications, in many cases replacing Bronze.

brass and bronze, and shows conclusively that, from a general point of view, the austenitic cast irons have properties very similar to the non-ferrous alloys. The castings can be produced at a price competitive with brass and bronze, and, for this reason, in some types of construction, it is being found an economic proposition to use the high-alloy cast irons in place of the latter materials. Fig. 7 shows a typical group of castings in austentic cast iron, amongst which are examples of castings used in general engineering equipment which, while originally made in bronze, are now being successfully manufactured at lower production costs in the austenitic iron.

Erosion Resistance.

In referring to the amount of alloy additions necessary to produce the austenitic structure, stress was laid on the fact that the figures mentioned were for the minimum amount of alloy additions necessary in each case. This is of vital importance, since it has been found that, where the minimum amount of alloy has been used, although the castings were obtained in the austenitic condition, on machining, trouble was experienced due to the fact that the castings hardened under the tools and presented considerable difficulty in cutting. The reason for this trouble is, as in the case of the austenitic steels, that the structure of the metal tends to revert to the martensitic state on being stressed. From a general point of view this tendency is regarded as a nuisance in the machine shop, and steps must be taken to use sufficient alloy elements to overcome the difficulty. This is usually easily effected by increasing the addition of nickel or of nickel plus copper by 3 or 5 per cent. above the minimum figures given.

In certain applications, however, it has been found that this special property of the alloys is of commercial importance. For example, under conditions where the castings are subjected to erosive conditions by impingement of solid matter, then the surface of the castings will harden due to the formation of martensite as in the case of manganese steels, and a marked resistance to the erosion is obtained. This property is of value in connection with the construction of equipment to handle suspensions of fine solids in liquids, such as occur in handling sea water in tidal estuaries, where sand and other solids will be in suspension. In chemical works where crystallising solutions have to be passed through such equipment as pumps, etc., the combined corrosion and erosion resistance of the alloys prove of special value.

Heat-Resistance.

The austenitic cast irons show a marked superiority over ordinary cast iron when subjected to temperatures up to about 800 deg. C. The matrix of the alloys is not readily oxidised and, furthermore, no critical structural changes take place, as in ordinary cast iron, thus eliminating such causes of "growth" as internal cracking due to sudden volume changes followed by internal oxidation.

For heat-resisting applications it is found of benefit to use chromium up to the highest limit compatible with the strength and machining requirements of the casting, the chromium adding materially to the heat-resistance and the strength of the metal at elevated temperatures. Generally 5 or 6 per cent. of chromium may be used in compositions giving irons just in the austenitic range without introducing too much difficulty in machining.

Amongst many of the successful applications of cast iron of the austenitic type as heat-resisting alloys, mention could be made of the spacers which were used in supporting the super-heater tubes in the "Yarrow" boilers on the "Empress of Britain." After seven months' service at 538 deg. C. the castings were reported as being as good as new, and when examined after 15 months' service, no failures or trouble have arisen.

A recent development in this field is that of "Nicrosilal." This alloy, which has been developed by the British Cast Iron Research Association is now the subject of a patent application. It consists essentially of an iron in the austenitic condition, in virtue of the presence of 18 per cent. of nickel with a small proportion of chromium. The heat- and scale-resistance of the alloy has been enhanced by the use of an abnormally high silicon content, this being as much as 6 per cent.

Magnetic Properties.

The demand of the electrical industry for castings which are non-magnetic was originally supplied by the use of such non-ferrous alloys as common brass. The austenitic cast irons, however, now offer a more satisfactory solution of the problem, the irons proving cheaper in price than the non-ferrous alloys formerly used, and, at the same time, offering superior foundry and mechanical properties.

Although "Nomag" was developed in the first place as a cast iron for use for non-magnetic castings, it is now realised that any of the austenitic irons can, with suitable control of composition, be used in this application.

Figures supplied by Messrs. Ferranti, Limited, for their "Nomag" iron, show that this material has a magnetic permeability of about 1, as compared with 240 for ordinary cast iron and 8,350 for steel. It is thus seen that the austenitic iron is equivalent to such non-ferrous metals as copper and brass in its magnetic quality.

In selecting a composition of austenitic cast iron for non-magnetic applications care should be taken to see that the alloy additions are not excessively high, as it has been found that there is a tendency for the castings to become gradually magnetic again when additions of nickel appreciably above those normally found in the austenitic cast irons are present.

Electrical Properties.

It has been found that the austenitic cast irons possess a specific electrical resistance about 50 per cent. higher than that of ordinary cast iron whilst, at the same time, they have the added advantage of having a very low resistance-temperature coefficient. This means that not only can a smaller bulk of cast iron be used to obtain a given resistance, but also this resistance is much more uniform with varying temperatures than in the case of the ordinary iron, this being an important factor in such applications as resistance grids for controlling electric motors, as in traction equipment.

Alloys of High Expansion.

The coefficient of expansion of the austenitic cast irons is generally about 18 to 20 $\times 10^{-6}$ as compared with 12 $\times 10^{-6}$ for ordinary cast iron. This high expansion on heating has proved of special value in connection with applications where cast iron and aluminium alloys are required to work together at high temperatures, as, for example, in the case of cylinder liners and pistons in internal-combustion engines.

The expansion of this type of iron is actually almost identical with that of some of the newer modified aluminium alloys, and this offers a solution of some of the problems connected with piston slap which is caused by the differential expansion of the cast-iron and aluminium parts.*

Austenitic cast irons produced by additions of nickel or nickel and copper show hardness values which may be less than 100 Brinell. It has been found that additions of chromium, however, cause a rapid rise in the higher hardness-figures, due most likely to the formation of chromium carbides. Under certain circumstances the austenitic cast irons have shown a good resistance to wear, especially under lighter loads. In circumstances where bearing loads are heavier, however, it is considered desirable to increase the hardness by means of chromium additions.

Practical Considerations.

The austenitic types of cast iron present no special difficulties in their working and use. The alloys can, in general, be made up under ordinary foundry conditions, passing the necessary

(*Concluded on page 226.*)

* F. Jardine, "Thermal Expansion in Automotive Design." "Society Automotive Engineers' Journal," 1930. XXVIII.

Modern Converter Practice.*

By W. R. Cooper.

Although this Paper is headed "Modern Converter Practice," the word "modern" is used with some hesitation, as it is realised that the converter process for the manufacture of steel cannot be regarded as a modern one, and, in fact, steel so produced is definitely out of favour with certain inspecting and consulting engineers. The author is inclined to agree that steel produced in large quantities from the bottom-blown Bessemer converter deserves this disfavour, but it is unfair to use this generalisation in the case of the Tropenas process, which is, as is well known, a modification of the Bessemer.

This process is particularly well suited for use in light jobbing foundries which may on occasions desire to produce castings of 1 ton or even more in weight. Moreover, apart from this adaptability the Tropenas converter will produce steel which readily meets the required specifications for engineering purposes and compares very favourably both in point of quality and cost with acid and basic open-hearth and even electric-furnace steel.

In support of these statements the following figures are interesting. From steel used for castings with wearing surfaces results obtained are 38 to 42 tons per sq. in. tensile stress; 25 to 30 per cent. elongation, with a 40 to 60 per cent. reduction of area, whilst from non-wearing surface steel the results obtained are 26 to 35 tons tensile, 32 per cent. minimum elongation, with a 56 to 70 per cent. reduction of area. These figures may be obtained from average practice and are not exceptional results. In this Paper, then, an attempt has been made to review the more interesting and important features of the Tropenas process for the manufacture of high-quality steel.

The molten metal generally charged to the side-blown Tropenas converter is of the following approximate analysis: 1.75 to 2.0 per cent. silicon and 0.60 to 0.80 per cent. manganese. The success of the blowing operation depends to a large extent upon the uniformity of the original melting which is taken care of by cupolas, and a word as to the handling of the cupola will not be out of place here. The efforts of the metallurgist and blower are set at naught and successive heats of cold steel are turned out if the cupola gets behindhand and delivers cold metal. Small cupola charges with properly-proportioned coke are advisable, and every effort should be made to keep the cupola running smoothly. If measures are not taken to ensure this uniformity, any irregularities which may occur during the melting of the metal will have adverse effects during the blowing period, and on occasions the quality of the steel produced is affected.

To commence operations, the vessel is turned forward and the metal for converting is transferred from the cupola by means of an intermediate ladle. The weight of each charge of molten metal is of first importance and is fixed by the fact that the level of the metal must be such that the blast will impinge on the surface of the bath beyond the centre-line of the vessel. The individual weight of each charge will gradually increase as the lining of the converter wears away, but in practice this weight usually averages from 27 to 30 cwts. An overcharge of metal to the converter results in considerable unpleasant slopping from the mouth of the vessel, and the time usually taken for blowing is extended. Short weight of charge results in excessive damage to the lining of the converter and the blowing of cold metal.

Immediately the converter has received its charge, the maximum blast pressure, which should be approximately 4 lbs. per sq. in., should be turned on and the vessel gradually raised until it stands at an angle of between 20 and 25 deg. to the vertical. Providing that this angle has not been made too small, the heat will "light up" in about four minutes.

In the first stage of the blow or "lighting up" there will be little real flame, but a considerable shower of sparks. During this period a small quantity of carbon is oxidised, whilst the volume of red smoke given off shows the oxidation of small quantities of iron.

The shower of sparks will gradually die down and a distinct flame appear. This means that the blast has produced mechanical and chemical action in the bath. At this point the converter should be raised to a position of about 15 deg. to the vertical and the blast reduced to about 2½ lbs. per sq. in. The lower the blast pressure from this period until the end of the blow, the higher will be the quality of the steel produced, but it is unwise to reduce the pressure below 2 lbs. per sq. in., as there would then be considerable danger of the metal running back into the tuyeres and wind box.

Flame Utilisation.

The flame will be yellow in colour and fierce. A proper judgment of the flame at this period is vital to the success of the blow. A long yellow flame, with no colour round the edges coupled with little throw out, which is not very incandescent, will indicate that the metal is cold, and little oxidising action taking place. A short, light, ripping flame with red-tinged edges, together with considerable incandescent throw out of slag and metal, will indicate that the bath is hot. Excessive throw out, indicating violent mechanical and chemical action, which may happen, must be checked by adjusting the blast pressure and the vessel angle. To increase the temperature of the bath, ferro-silicon may be thrown into the vessel. This addition of ferro-silicon will lengthen the blow, consequent on the extra time taken for its oxidation and delaying the oxidation of the carbon.

The appearance of this distinct flame will denote that the silicon and manganese in the metal are being oxidised. Whilst the silicon is being oxidised, the violent agitation of the slag may cause some of it to lodge in the mouth of the vessel and break the flame. This may be removed with a long rake from the charging platform.

The silicon flame will eventually die down and the bath lie comparatively quiet for a short time. Slowly, but distinctly, the flame will lengthen and become more brilliant and feathery at its upper edge. This will denote the commencement of the oxidation of the carbon. This long brilliant flame will continue until the carbon in the bath reaches about 0.10 per cent., when it will distinctly drop.

When this point is reached, the converter must be simultaneously turned down and the blast shut off. It is important that the vessel is turned down at the critical moment, otherwise the remaining carbon will be eliminated and the metal become over-oxidised. It is useless to attempt to make high-carbon steels with any degree of certainty by stopping the process when it is judged that the right amount of carbon is still left in. Even the use of the spectroscope, which is considered by some people to be of great assistance in acid blowing, cannot be recommended for this purpose. The only successful practice is to blow down to dead softness and then recarburise.

Recarburising in the vessel is a very common and successful practice, partly owing, no doubt, to the inviting angle at which the vessel stands when turned down, with its open throat conveniently disposed to throw or pour in the recarburisers. For ordinary purposes the recarburisers used are spiegel or ferro-manganese, and pig-iron, pre-heated by means of a coal- or oil-fired reverberatory furnace. When, however, high-carbon steels are required the use of cupola metal can be recommended as giving excellent results. The success of this practice depends upon the transfer ladle being balanced on a simple weighing machine and so designed as to enable it to be easily and rapidly swung from under the cupola launder over the mouth of the converter.

The complete chemical reactions of the process are rather complicated and only allow of very brief reference here. It is contended that the tilting of the converter gives a valuable power of controlling the rate at which oxidation proceeds, and that much less blast pressure is necessary than in the ordinary type of converter. Moreover, the excess of air causes the carbon monoxide formed to burn inside the converter and thus keep up a high temperature, whilst the circulation of the metal, due to the direction in which the blast is sent in, ensures all the metal being brought under oxidising influences. Evidently, as the blast rushes over the surface of the bath, silicon, manganese, carbon and iron are oxidised and a slag formed which grows progressively richer and richer in FeO as the silicon, manganese and carbon are eliminated from the surface metal, leaving the iron unprotected and hence more free to oxidise. As the oxidation of the constituents progresses, a point is reached where the slag becomes very high in FeO available for reaction with carbon. Doubtless the action of the blast is largely confined to the upper layers of the metal reducing its contents of silicon, manganese and carbon to a very low point and oxidising much of its iron to FeO. Then the effect of the slag on the metal begins to be more violent, probably assisted by circulation of carbon into the upper layer from below, the bath of metal and slag begins to boil the FeO, oxidising silicon, manganese and carbon from the metal rapidly and soon the boiling becomes very violent. A long flame is thrown out because the CO is evolved so rapidly that it burns to CO_2 largely at the vessel's mouth. Upon the exhaustion of the available FeO of the slag, this reaction subsides and the bath well mixed by the strong boil, is again subjected to slow oxidation followed by renewed boilings when the slag reaches the proper composition.

If mixtures are blown that contain from 0.75 to 1 per cent. of manganese with the usual silicon, the boiling and slopping are very violent and result in an excessive loss of metal. This is no doubt due to the fact that the MnO formed by the combustion of the manganese makes the slag very liquid and promotes the reaction between the carbon of the bath and the FeO of the slag.

The limitations of this process are chiefly confined to certain alloy steels—namely, chrome, tungsten and molybdenum steels—although it is possible to produce steels containing a percentage of these alloys. In this connection, however, it should be remembered that particularly if heavy additions are to be made to the steel in order to secure high-carbon content or high content in certain alloys, it is essential to melt these additions. If this is not done the steel is so chilled by the additions that it becomes difficult to pour it.

Sulphur Control.

The control of the sulphur content is one of the most important problems which the modern foundry has had to face. The harmful effect of sulphur as an impurity has long been emphasised and there is an increasing tendency to impose rigid specifications, which demand a low-sulphur content. The problem is of special importance in the case of the Tropenas converter because

* A Paper presented to the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen. Mr. F. J. Hemming presiding.

there is no elimination of sulphur in this process; on the contrary, there is an increase in the finished steel due to a loss of steel in blowing. In order, therefore, that the amount of sulphur in the finished steel shall be kept within reasonable limits, it is necessary to use pig-iron of a very low sulphur content and high-grade coke. Even so, the best average which can be obtained is round about 0.06 per cent., and a much lower average than this is desirable if present-day specifications are to be met.

However, these difficulties have, to a large extent, been overcome by the use of soda ash as a desulphurising agent. The procedure adopted for the desulphurisation process is as follows:—A quantity of dry soda ash equal in weight to 0.75 to 1.00 per cent. of the metal weight is poured into the bottom of the intermediate receiving ladle and the metal from the cupola is tapped on to this in the usual way, except that in this case the temperature of the metal should be as high as possible. A vigorous action takes place between the metal and the alkali with rapid evolution of carbon dioxide and the formation of sodium sulphide and other sulphur compounds. Usually a thin soda slag containing sodium sulphide and other sulphur compounds collects on the surface, and this slag must be removed as completely as possible by scraping off before transferring the metal to the converter. The one outstanding objection to this treatment of the metal is that the siliceous refractory lining of the converter is attacked to an appreciable extent by the sodium compounds, all of which it is impossible to remove by scraping off of the surface slag. It is, therefore, imperative that the surface of the metal is scraped as free from slag as possible, and it will assist matters if the ladle of metal is allowed to stand for several minutes before scraping clean in order that the maximum amount of the slag may float to the surface.

Average analytical results taken before and after treatment show a reduction of 50 per cent. in the sulphur content of the metal. It will be seen, then, that the sulphur content of the steel so treated has reached the low average of 0.035 per cent., which is indeed a very gratifying result.

In conclusion, it can be definitely asserted that the Tropenas process manipulated efficiently and using desulphurised metal can be used with confidence for high-quality castings, and the mobility of this process is far superior to either the open hearth or electric furnace.

British Chemical Standard Alloy Steel "W2."

The headquarters of British Chemical Standards announce a renewal of high-speed alloy steel "W" having the following standardised analysis: Carbon, 0.17; silicon, 0.14; sulphur, 0.051; phosphorus, 0.026; manganese, 0.22; chromium, 3.29; vanadium, 0.82; tungsten, 16.12; cobalt, 4.35; nickel, 0.43; molybdenum, 0.55 per cent.

It will be noticed that in addition to the alloy elements which were in the original standard "W" the renewal contains molybdenum, which now seems to be frequently used. The standard will be useful for checking all high-speed steel analyses, also cobalt magnet steels, chrome-molybdenum steels, etc. The certificate of analyses, including an outline of the methods used, gives the analytical results of nine different chemists, representing independent analysts, a Government Department, steel manufacturers and motor-car makers—who are large users of high-speed steel. A copy of the certificate is sent out with each bottle, which is sold in units of 25 grms., 50 grms., 100 grms. and 500 grms. at a price which it is estimated will eventually cover the cost of preparation.

The Relation Between Shape of Grain and Strength of Sand.*

By H. Ries and H. V. Lee.

While it is a well-known fact that moulding sands may vary in their compressive strength and permeability, it is probable that this variation has usually been charged against the amount and character of bond and size of the grains. It seemed possible, however, that the shape of the grains might exert some influence, and the experiments described herein may be regarded as a preliminary effort to obtaining some information on this point.

Plan of Experiments.

The plan of work outlined consisted in selecting three pairs of sand samples free from clay bond, the grains of each pair being as nearly the same size as possible. One sand of each pair had grains that were as well rounded as it was possible to obtain, while the other one consisted of angular grains. Each of these sands was mixed with 15 per cent. of English ball clay, which has strong bonding power. The clay and sand were mulled in a laboratory mixer with different percentages of moisture, and then tested for green compression, green permeability and tension, as well as baked compression and baked permeability. The baked specimens were heated for two hours at 150 deg. C.

Sectioning.

In addition, the baked samples also were ground to thin sections and studied under the microscope. For this purpose the specimen had to be embedded in a hardening medium. The method first tried consisted in soaking the specimen in hot kollolith, after which it was allowed to cool. However, this did not prove satisfactory as the material was not hard enough.

Table I.—*Test Results on Two Pairs of Sands.*

No. and size of sand.	Moisture, per cent.	Green Sand.		Baked Sand.		
		Permeability.	Compression, lbs. per sq. in.	Permeability.	Compression, lbs. per sq. in.	Tension green, oz. per sq. in.
No. 1: Round grains 0.3–0.6 mm. dia.	5	152	3.5	185	50	7.65
	7	146	2.9	193	70	7.00
	9	115	1.8	178	76	5.73
No. 4: Angular grains 0.3-0.6 mm. dia.	5	193	2.6	146	37	7.65
	7	313	2.8	243	40	5.1
	9	230	1.3	235	43	5.1
No. 5: Round grains 0.3–0.9 mm. dia.	5	168	9.5	119	65	9.55
	7	118	3.3	119	95	12.73
	9	119	2.0	160	110	7.0
No. 6: Angular grains 0.3-0.8 mm. dia.	5	330	2.5	300	32	7.0
	7	362	1.3	312	85	5.73
	9	119	1.5	230	70	6.36

Bakelite then was tried, and this gave more satisfactory results. The grade of bakelite used was AR-0014. This was warmed, and chips of the baked sand-clay mixture, previously warmed, were placed in it. After allowing the specimen to soak up bakelite for about an hour, it was heated at 70 deg. C. for 4 hrs., then at 95 to 100 deg. C. for 6 to 8 hrs. If the fragments were well hardened, they were cooled slowly and then ground to thin sections which could be studied under the microscope. The data of Table I show the results obtained on two pairs of sands.

The figures in Table I indicate that the mixtures with rounded sand grains showed lower permeability and higher compression, in both the green and baked condition, than those with angular grains. Thin sections of the sand-clay mixture also showed that the clay seemed to be more evenly distributed around the rounded grains than around the angular ones.

* Paper presented before 1931 Convention of the American Foundrymen's Association.

Behaviour of Round and Angular Grains.

The difference in distribution of the clay around the two types of grains may possibly be due to several causes. When the round grains are mixed in a muller type of mixer, they roll around more readily and thus become more evenly coated with clay, whereas the angular ones, because of their shape, will not become so regularly coated. The difference in compressive strength shown by the round and angular grains may be explained by the fact that in the rounded grains we not only have a larger number of surfaces in contact, but the contact is a better one; and, since the clay is more evenly distributed, there is always a film of it between the grains.

In the angular ones the contacts are very irregular, the points of contact may be very small and sufficient bonding material may not always be present. The tensile strength might be affected in the same way as the compression. Turning now to the permeability, one finds that this behaves the reverse of the strength, being greater with angular grains than with round ones. The explanation that suggests itself here is that round grains pack together more tightly than the angular ones. One interesting result developed when the effect of excessive ramming was tried. It was found that up to 4 rams with the standard rammer, the two types of grains showed a somewhat similar densification, so far as one could determine from the permeability, but from 4 up to 10 rams the angular grains seemed to compact more than the round ones.

The experiments and results outlined above are to be regarded as preliminary, and not necessarily conclusive. If further experiments are carried out, it would be very desirable to use sands that show the minimum range of grain sizes and also are very well graded as to shape. It is doubtful whether any natural sand will meet these requirements.

After the experiments outlined in this Paper had been completed, there appeared a Paper by H. C. Nipper and E. Piwowarsky,* in which the authors, in a somewhat lengthy Paper on the properties of moulding sand, discuss the relations between strength and shape of grain. In this Paper they remark that angular grains behave differently from rounded ones in a clay-sand mixture. They give a number of tables of compression tests, made on clay-sand mixtures containing both round and angular grains, which are interesting but not always valuable for purposes of comparison, for the reason that the different sets of mixtures were not always subjected to the same amount of ramming.

* "Formsanduntersuchungen," "Die Giesserei," No. II, page 237, 1929.

Rubber- and Bakelite-Bonded Wheels.—For cleaning ingots and billets, and general foundry cleaning work, rubber-bonded and bakelite-bonded wheels are coming into use. The pressure between the work and the wheel is important, for with rubber-bonded wheels the lowest cost per pound of material removed is when a pressure of about 60 lbs. is used. With bakelite wheels the best pressure is about 100 lbs. Rubber-bonded wheels appear to be the best where the pressures exerted are moderate and there is not much edge grinding. Bakelite wheels can be used with a higher pressure and are not so much harmed by severe edge grinding.

Wrought Hollow-ware of Iron or Steel.—The Board of Trade have referred to the Standing Committee an application for an Order-in-Council to require the marking with an indication of origin of imported wrought hollow-ware of iron or steel, whether self colour (plain), galvanised, tinned, japanned, painted, lacquered or varnished (not including hollow-ware of tinplate, enamelled hollow-ware, or kegs and drums). Representatives of any interests substantially affected by the application who desire to be heard in opposition at the public inquiry which will be held later by the Committee should communicate with the Secretary, Mr. E. W. Reardon, at the Board of Trade Offices, Great George Street, London, S.W.1, as early as possible and in any case not later than April 30, 1932.

Foundry Selling Practice.

By Eric N. Simons.

(*Continued from page* 171.)

No. 15. STIMULATING PIONEER WORK.

In a previous article, the importance of pioneer work, *i.e.*, the making of new customers, to the foundry, was pointed out, and the all-too-frequent theory that the salesman's interests are identical with his employer's was attacked. It was argued that it was wrong to let the salesman bear all the expense of visiting isolated firms and new firms, and suggested that it was not beyond the human intelligence to find some means of so paying a representative that he should regularly devote a portion of his time to breaking fresh ground. Now the hints thrown out in the succeeding paragraphs must not be taken as exhausting the possibilities of efficient remuneration. Obviously, methods of payment of salesmen will vary considerably, and any special payment plan to promote new accounts must be adapted to the existing system of the foundry concerned. But with this qualification made, one may throw out a few broad ideas that may be found of value.

Fixing the Bonus.

The first suggestion, then, is to offer the representative a bonus on each new account he opens. This can either take the form of a cash payment or, preferably, an increase in commission, fixed on a sliding scale according to the value of the first order. Thus, if a trial order for only one small casting were received, it would not be policy to give the salesman a large cash bonus. But if this trial order were followed by a bulk order, then perhaps a bonus corresponding to the value of the order could be given. There are various ways of arriving at the value of any such bonus. Commission on a first order might be doubled, for example. Some firms, alternatively, fix a cash bonus of, say, £1 on every new account, irrespective of its value. This, to the writer, seems a mistaken plan, as it tempts the representative to concentrate on getting small trial orders, receiving his bonus, and then neglecting to follow up the trials and turn them into good accounts. Other firms ignore any trial order under a certain value, but pay a bonus on the first substantial order. This, however, suffers from the defect that it throws more risk on the representative. He may go to much trouble to secure a trial order, and the works may bungle the job, with the result that a second order never comes, so that he gets nothing for his trouble. If this bonus per order system is adopted, the best method seems to be to give a small bonus on the first trial order, and a proportionate bonus on the first bulk order, after which subsequent orders come under ordinary commission rates.

But some foundries will not be able to adopt this plan of a bonus on each new account as opened, owing to the fact that their commission rates on different types of castings are so nicely calculated that the giving of bonuses over and above commission to the representative would eat up the profit on a particular type of casting, the price for which may be cut very fine. In such circumstances, an alternative method is to record the various new accounts opened by a representative during the course of a year, in all types of castings, including both small trial and the first bulk orders, tot up the total value of these, and grant a percentage bonus on this total. Thus, if the total value of new accounts opened by Brown in Wales were £5,000, he might be given a bonus of 1 per cent., *i.e.*, £50. This bonus should constitute not a charge against the various foundry orders, but an overhead charge on the business as a whole.

But we have still to face the fact that after expending, say, £100 in pioneer work expenses, Brown may not get anything like £5,000 worth of new business, at all events in the first year. Suppose he gets only £500, his commission (say 5 per cent.) will be £25, and his bonus (say 1 per cent.) £5, so that he will be £70 out of pocket. His firm, on the other hand, assuming a mean profit of 10 per cent., will have £50 less £5 bonus, *i.e.*, £45. They will, therefore, be in pocket, their representative not. This is hardly fair, and Brown knows it. How is he to be tempted to risk £70, in the hope that one day he will get it all back and more? Obviously, a £5 bonus is not going to do it. It seems that the obvious answer is either a drastic revision of the method of payment, so that all travelling expenses are paid by the foundry (as is done, for example, when a director or special representative takes a pioneer trip abroad), salary and commission being proportionately less, or a sharing of the expenses on pioneer work alone.

How would this latter suggestion work out in the imaginary instance quoted? Brown would spend £100 in pioneer expenses, and would necessarily have to render a strict and detailed account of his expenditure. He would receive £50 towards these expenses from his firm, and would finish up thus:—Expenditure, £100; receipts, £50; commission, £25; bonus, £5; total, £80. He would thus be only £20 out of pocket, which he would have a fair chance of getting back the following year, or in repeat orders. His firm would spend £50 expenses, £5 bonus, total £55, and receive £50 profit. They would thus be £5 out of pocket, which they, too, might reasonably expect to get back in the next twelve months. The author has only thrown out the equal sharing of expenses in pioneering work as a suggestion. A more elaborate division might be decided upon, or the proportions might vary.

Now it is the essence of any arrangement of this sort, where it is not desired to upset existing methods of payment too greatly, that this sharing of expenses should be confined to pioneer work, and it is in the deciding what is and what is not pioneer work that the principal difficulty might lie. But the difficulty is not an insuperable one. It is obvious that the sales manager would have to be notified in advance of any pioneer trip proposed by the representative, and he should be satisfied in his own mind that the trip is one worth undertaking. Otherwise, some unscrupulous representative might arrange a trip to Llandudno or Colwyn Bay for a week, and set down his expenses as pioneering work to which he desired a contribution. The salesman should clearly indicate the district he proposes to cover, the firms on which he intends to call, and should furnish clear proof that he has called on those firms, and that his expenses have been what he declares. Thus much the foundry has a right to demand.

Now what would be the result of these attempts to share the risk of pioneer work? It seems fairly obvious that the salesman would have a much greater incentive to go after new business; and that the foundry would have a much stronger moral right to insist on his going after new business. After all, when a firm is not paying a man's expenses, it is not very easy for them to force him to lay out his own money on what he may (rightly or wrongly) regard as a wild-goose chase. The writer's own feeling is that all travelling expenses up to a certain maximum should be borne by the foundry, a fixed sum per day or per week being allowed. But this opens up a much larger subject, the remuneration of salesmen generally, which cannot be dealt with in this article. Here, the writer has endeavoured to concentrate on means of stimulating pioneer activities by representatives, and as this is an important matter, he hopes that readers will find time to give their views and experiences in the correspondence columns of this Journal.

(*To be continued.*)

A New Welding Material for Manganese Steel.

At a meeting of the American Society for Steel Treating, held in New York recently, Mr. J. H. Hall stated that until quite recently autogenous welding of Hadfield's manganese steel has not been satisfactory, because of the unreliability of the welds secured, due to the fact that the heat of welding damages the manganese steel close to the weld, and when welding rods are used, which deposit metal of analysis similar to the castings, failure of the welds in service often occurred in the damaged metal close to the weld.

About four years ago the Taylor-Wharton Iron & Steel Company developed a special manganese steel, known as "Timang," which contains from 0.60 to 0.80 per cent. carbon, from 12 to 15 per cent. manganese and approximately 3 per cent. nickel. This steel does not require water quenching to retain the austenitic condition with its accompanying strength and toughness, and ordinarily "Timang" steel parts are heat-treated simply by normalising. With "Timang" welding rod the contact zone between the weld and the underlying manganese steel is far stronger than when welds are made with normal manganese-steel rods. This is thought to be due to the dilution of the carbon content in the contact zone and to its impregnation with nickel by the metal derived from the welding rod. In any event it has been found by many types of laboratory tests that manganese-steel parts welded with this new material are far stronger than similar parts welded with normal manganese steel.

Broken street-railroad-switch tongues have been successfully welded with this new rod and restored to service. Frogs, switches and crossings for steam and electric railroad service, which have been worn down at the intersections, likewise have been successfully restored to their original elevation at a large saving over the purchase and installation of new castings. In addition a wide range of manganese-steel crushing and wearing parts is being restored to service by this kind of welding. The wear secured from the welded part is in the majority of instances satisfactory, and is sometimes even as good as that of the original casting.

In addition to its use as a material for welding manganese steel, "Timang" is sold in the form of castings and also as rods, plate and sheet. In castings the principal applications are in parts subjected to heavy wear and at the same time to temperatures up to 600 deg. C. Long exposure to temperatures between 300 and 600 deg. C. destroys the strength and toughness of normal manganese steel, but the new material is found not to be damaged by these temperatures. As a result it has been used for numerous applications in steelworks and other industries requiring a material capable of resisting heavy wear associated with exposure to hot materials. In rods the chief applications so far have been in woven screens. As plate it is used for shute liners, elevator buckets, car bearing liners, etc.—"The Iron Age."

International Tube Syndicate.

According to information received in Essen, at the recent meeting at The Hague of the members of the International Tube Syndicate, it was decided in principle to prolong the agreement, which would nominally have lapsed with the end of March, until the year 1935, although the possibility exists of giving notice to determine it at the end of a year. Apparently it has been possible to induce the British and American works to continue for the same period. The price agreement with the Swedish works is said not to have yet been renewed, while Japanese works now appear also as competitors in Europe. The Syndicate covers gas and boiler tubes, the former up to a size of 6⅝ in., as well as oil pipe-line tubes.

Institute of British Foundrymen.

SCOTTISH BRANCH ANNUAL MEETING.

The annual general meeting of the Scottish Branch of the Institute was held in the Royal Technical College, Glasgow, on March 19. Mr. N. McManus, M.B.E. (Branch-President), was in the chair.

The Chairman said that they had now arrived at the time to review the position of the Branch and its activities during the past twelve months, and in view of the lengthy programme before them he would at once ask the secretary to read the annual report.

The Hon. Secretary (Mr. John Bell) said that as the members had been in possession of the report for some days it would be unnecessary to read it in full, but there were a few points to which special attention might be directed. He wished to remind the members that it was the ninth report that it had been his privilege to present, and to say that he considered that in every respect it was the best of the nine reports. There were one or two items which should be added to the report. Firstly, the Branch had suffered a loss by the removal of Prof. Andrew from Glasgow to Sheffield. Dr. Andrew had not been a very regular attender at their meetings and might not have been known intimately to many members, but the Syllabus Committee and many of the Council knew that he was always willing and anxious to render any assistance and to give service to the Branch and the Institute. The Council had sent Dr. Andrew a letter of congratulation upon his new appointment on behalf of the Institute. In his acknowledgment Dr. Andrew had stated that one of his chief regrets in leaving Glasgow was his severance from the Scottish Branch.

Local Educational Development.

The second matter was the negotiations which had taken place between the Council and the Glasgow Corporation Education Committee in regard to classes for students preparing to sit for the Institute's certificate in foundry work and patternmaking. At the request of the Corporation an advisory committee, consisting of the President, Messrs. Campion and Russell and the secretary, to confer as to the classes. In the course of a year or two good results should be obtained.

In Edinburgh there was also a local committee assisting the education authority.

The Chairman said that he thought the report left little ground for criticism or complaint, and that very few members could have many questions to put in regard to it. Personally, he considered it a record of a session of excellent work. He proposed that the financial report should then be presented, and could be taken for discussion along with the general report.

Mr. John Bell then presented the balance-sheet and financial report, giving details of certain of the items.

The Chairman said that the financial statement appeared to be very satisfactory, but was, along with the secretarial report, open for discussion.

Mr. D. Sharpe, in moving the adoption of the reports, said that, as printed, the figures appeared very satisfactory, but after hearing the explanations by the secretary, they seemed even more satisfactory. He thought that many members would have only a hazy idea of what the figures meant and a still more hazy notion of the work entailed in the compilation of the figures. It was due to Mr. Bell that the report was so satisfactory, and the members should feel grateful that it was possible to make so satisfactory a statement. He formally moved the adoption of the reports.

Mr. J. Longden said that both reports were very creditable productions, and he had much pleasure in seconding the adoption of the report.

The reports were unanimously adopted.

At this stage the Institute diploma and the John Surtees Memorial medals and prizes were presented by Col. A. D. McInnes Shaw, D.S.O., D.L., J.P.

The New Officers.

Mr. McManus said it was difficult to realise that that was practically the end of the session and almost the last meeting of the Branch over which he would preside. The time had come to elect new officers. He wished to thank all who had so faithfully supported him during the session. It was with great diffidence that he undertook the duties of President, but with the loyal assistance of the Council and their energetic secretary it had been a very pleasant time. He thought they should tender thanks to the retiring members of Council who had served the Branch so well during their period of office.

He would be glad to receive nominations for the various offices; in order to save time the Council had made certain suggestions, but it was open to any member or associate member to put forward other names.

Mr. H. D. Campbell, of Messrs. Shaw Glasgow, Limited, was elected President.

Messrs. John Currie and H. Hurst were elected Senior and Junior Vice-Presidents, respectively. Members of Council were elected as follow:—Messrs. F. Hudson, Evan J. Ross, D. Walker and Daniel Sharpe. Messrs. Jas. Affleck, B.Sc., J. W. Donaldson, D.Sc., A.I.C., James M'Arthur, N. McManus, M.B.E., and Thomas Shanks were elected representatives to the General Council. Mr. John Bell was re-elected hon. secretary.

The Chairman said that he wished Mr. Campbell, whom they had elected to watch over the destiny of the Branch next session, a very pleasant and successful year of office. He bespoke for him the same loyal support and assistance as had been accorded to himself. He wished to take that opportunity of proposing a vote of thanks to their very energetic and efficient secretary for all the work which he had done on behalf of the Branch during the past year, which had been one of exceptional activity. The vote was enthusiastically passed.

The Secretary proposed that they should record a vote of thanks to the Governors of the Royal Technical College for having provided accommodation for their meetings free of cost. This was carried with acclamation.

The Chairman said that having concluded the business meeting they were now to have a discussion on the subject of Green-sand *versus* Dry-sand Moulding. Mr. Hudson had agreed to open the discussion and to tell them about certain investigations he had been making. He would without further remark ask Mr. Hudson to give his Paper.

Continental Steel Cartel.

In order to be prepared to meet the situation in case the Continental Steel Cartel is not renewed, Germany—according to a French paper—is contemplating a restriction of the imports of certain iron and steel products which are exposed to foreign competition. It is said that the maximum tonnages to be admitted into Germany will be as follow (per annum):—Pig-iron, 90,000 tons; semi-products, 75,000 tons; joists and commercial steels, 240,000 tons; large flats, 17,000 tons; thin sheets, 35,000 tons; steel tubes, 5,000 tons; cast-iron pipes and other foundry products, 15,000 tons; rails and rolling-stock, 50,000 tons; wire-mill products, 70,000 tons; scrap unlimited. This list—it is said—has been submitted to the Federal Government and approved. The restrictions will come into force as soon as the Continental Steel Cartel is dissolved, in the event of a dissolution taking place.

The annual general meeting of the London Iron and Steel Exchange will be held at the Cannon Street Hotel, E.C.4, on Tuesday, April 12, at 3.15 p.m.

Book Review.

Engineering Materials, Vol. II, Non-ferrous, by A. W. Judge, Wh.Sc., A.R.C.S. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 40s. net.

Actually, this volume also includes organic materials, and the reviewer confesses to but a hazy notion of rubber, paints, dopes and varnishes, and his remarks are thus confined to the balance of the book. If we sent the book along to an expert in these sections, he would probably be unable to appraise the worth of the non-ferrous section. The book is mainly a compilation of existing knowledge of the various alloys, both proprietary and conventional, entering into the non-ferrous category. The author has wisely stressed in his preface that "the present volume is not a metallurgical treatise, but an elementary text-book on engineering materials written from the viewpoint of the practical user of these materials." This, of course, does provide the author with a tangible reason for detailing so many of the proprietary alloys. The pure metallurgist is justifiably snobbish in his attitude to proprietary alloys, and if an alloy can be designated a silicon-bronze, he dislikes someone christening his own particular brand Q X H or X Y Z. Still, there is a distinct unfairness in referring to proprietary alloys of a controversial character, whilst omitting reference to such well-established alloys as Cindal and M.V. "C."

The non-ferrous section is contained in the first nine chapters, which cover aluminium, magnesium, beryllium, copper, nickel and their alloys, Monel metal, bearing metals, and die casting. Chapter XIX, however, returns to the question and catalogues the properties of about a dozen more metals. Chapter X, a matter of about 30 pages, deals with what the author has termed "synthetic products." In it one finds a good deal about gum products, but, to our mind, there is too much reference to the proprietary brands and too little to underlying principles. The author has certainly presented a really interesting section on timber, extending to about 140 pages. Much of this is of distinct interest to patternmakers. Chapters on plywood, rubber, paints and painting are followed by one on X-ray method of examining materials, which we consider to be the best in the book, as it holds a nice balance between the views of manufacturer and the inspecting engineer. The book is well indexed and illustrated, and, in general, fulfils the purpose for which it is intended. It could be improved by driving home to the engineer those factors in metallurgy which influence design very profoundly. V. C. F.

Dr. Adolf Sonnenschein.

The many friends in this country of Dr. techn. h.c. Ing. Adolf Sonnenschein, the general manager of the Vitkovice Mines, Steel & Ironworks Corporation, will congratulate him upon attaining his 70th birthday on April 3, after completing 44 years' service with this well-known Czecho-Slovak concern, which, under his guidance, has entered the front rank of leading works, both as regards size, equipment and organisation.

Mr. Sonnenschein has had an interesting career, which led him from Barrakar, India, where he was deputy-general manager of the Bengal Iron & Steel Company, Limited, to Koskullskule (Lapland), where he was in charge of the iron-ore mines of the Aktiebolaget Freja (belonging to the Vitkovice concern), and to Krasnogrigorjewka in South Russia, where he modernised, in the interests of Vitkovice, the manganese ore exploitation. Mr. Sonnenschein, who graduated from the Technical University of Vienna, has received the honorary degree of Dr. techn. of the Technical Universities of Prague and Brno (Brünn), and is chairman of many industrial associations and concerns.

The Formation of Graphite in Cast Iron.

The problem of the graphite formation in cast iron is not yet solved. Nowadays, many workers are of opinion that the double diagram of the iron-carbon system is only of theoretical value, and that, in cooling cast iron, cementite or ledeburite first separates from the melt and decomposes afterwards into graphite and mixed crystals. In a recent investigation, H. Hanemann has shown that the graphite separates directly from the melt.*

The iron used in these experiments was of nearly eutectic composition, containing T.C. 4.15, Si 0.09, Mn 0.18, P 0.024 and S 0.019 per

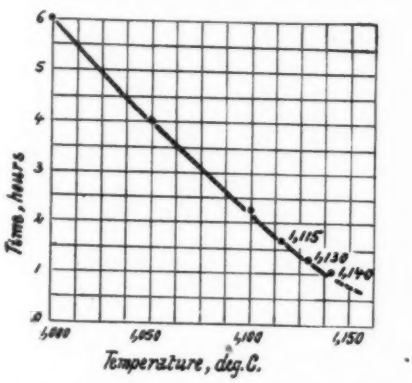


Fig. 1.—Decomposition Rate of Cementite at High Temperatures.

cent. At a cooling rate of 2 deg. C. per min., the eutectic point was found to be 1,141 deg. C. and the freezing period was 52 sec. with 15 grammes of melt. Samples quenched from temperatures above the eutectic point were wholly ledeburitic. Samples quenched from several points of the eutectic freezing range showed that with progressive solidification the grey areas increased. Samples quenched from

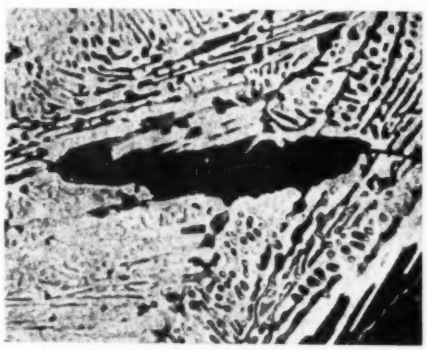


Fig. 2.—Graphite Flake Separated Directly from the Melt. × 800 dias.

temperatures well below the eutectic point were wholly graphitic. From this it can be concluded that the graphite had formed during solidification at the eutectic temperature.

It is possible, however, that the graphite did not separate directly from the melt but originated from cementite which, immediately after having formed, had decomposed. To settle this question, the decomposition rate of cementite was determined. According to R. Ruer and N. Iljin, in irons which solidified white, graphite or temper carbon nuclei form between 1,100 and 800 deg. C. Therefore, in the present experiments, cooling the samples below 1,100 deg. C. for an appreciable length of time had to be avoided, otherwise the graphite nuclei formed would have increased the tendency of the cementite to decompose. The procedure adopted was as follows. Small samples of molten iron were quickly cooled below the eutectic temperature by pouring them on an iron plate, then cooling was stopped and the samples, still yellow-hot, placed into annealing furnaces heated to definite temperatures beforehand. After definite annealing periods, the samples were quenched and microscopically examined. The experimental results are recorded in Fig. 1. The curve shows that, at the eutectic temperature, the complete decomposition of cementite takes about one hour. As solidification of the slowly-cooled samples only took 52 secs., it is obvious that the graphite found in these samples cannot be the decomposition product of cementite. Hence, it had separated directly from the melt.

This conclusion was confirmed by the microscopical examination of the samples quenched at various stages of solidification. In these samples ledeburite, as well as graphite and mixed crystals, could be seen. The ledeburite was surrounded by a border of cementite, a so-called eutectic border. If the mixed crystals, together with the graphite, had formed by decomposition of cementite in the solid state, such a eutectic border would not exist. It is inconceivable that cementite would form in the neighbourhood of crystals resulting from decomposition. Further, the graphite flakes extended into the ledeburite. Fig. 2 clearly shows that the ends of the graphite flake illustrated are enveloped by ledeburite. This flake cannot result from the decomposition of cementite, otherwise the second decomposition product, viz., mixed crystals, must be present at the ends. This is not the case. It only remains, then, that the graphite had crystallised in the molten iron together with the mixed crystals, by which it is enveloped in parts, whereas the ledeburite formed during quenching.

* "Stahl und Eisen," 1931. Vol. 51, pages 966-967

French Foundry Students' Annual Outing.

The usual travelling vacation course undertaken by the students of the Paris Foundry High School this year took them to the north of France. Owing to illness, Mr. Ronceray was unable to be with the party on the first day, and it was left in the capable hands of Mr. Debar. On Monday, March 21, a visit was paid to the Vicoigne, Nœux and Drocourt mines, where they were able to follow in detail the manufacture of foundry coke and to see something of the winning of coal. The next morning the party was shown over the works of the Paris Outreau Company at Boulogne, where most of the time was spent at the blast furnaces. The afternoon was spent in the steelmelting department and the iron foundry of the Société Métallurgique des Usines de Marquise. Wednesday was spent in the Lille district, where, quite early, a tour was made of the Massey-Harris Company's foundries. Here the students were received by Mr. Bowker and Mr. F. Ronceray and shown something of American methods of manufacture. The afternoon was spent at the Escaut and Meuse Works at Anzin, where they saw the manufacture of welded, laminated and drawn pipes.

The last day was spent at the works of Denain Anzin, where an inspection was made of the blast furnaces, iron foundry, rolling mills and basic-Bessemer shop, whilst after luncheon the tour took in the reversible rolling mills, the open-hearth plant and shops devoted to the preparation of the various refractories.

The system is, indeed, an excellent one, and the students before breaking up for their Easter holidays were delighted with the arrangements made for their comfort and enlightenment.

Association Technique de Fonderie.

MR. RONCERAY ELECTED PRESIDENT.

The French Foundrymen's Technical Association at its annual general meeting held on March 17 elected the retiring President, Mr. A. Damour, an honorary President and Mr. Charles Dufour, the President of the Foundry Employers' Federation, and Prof. A Portevin, the President of the French Institute of Civil Engineers, honorary members.

Mr. E. V. Ronceray, dean of the Paris Foundry High School and managing director of Bonvillain & Ronceray, foundry equipment manufacturers of Choisy le Roi, Paris, was elected President. As Senior Vice-President, the meeting chose Mr. Charles Koehler, managing director of the St. Ouen foundries and general secretary of the employers' federation. With him are associated the following seven Vice-Presidents:—Mr. E. Dady, President of the Foundry Mutual Benefit Society; Mr. J. Derdinger, brass founder and honorary President of Paris non-ferrous foundryowners' federation; Mr. F. Girardet, gear-wheel founder at St. Dié (Vosges); Mr. J. Lobstein, President of the Paris ironfoundry owners' federation and managing director of the Lobstein foundry at Argenteuil (Seine et Oise); Mr. H. Magdelénat, managing director of the Rosières foundry at Bourges (Cher); Mr. L. Montupet, managing director of the Montupet Foundry Company, Paris; and Mr. H. Strube, President of the Paris non-ferrous foundryowners' federation and owner of a foundry concern at Montrouge. The following foreign Vice-Presidents were re-elected:—Mr. J. Léonard (Belgium), Mr. J. M. Espana (Spain), Mr. C. Vanzetti, C.B.E. (Italy), and Mr. L. Brasseur (Luxemburg). The remaining offices, that of general secretary and treasurer, were filled by the election of Mr. R. Meyer, a director of the Société de Produits Métallurgiques, for the former and Mr. A. Lardin, manager of Messrs. Lardin & Company, Paris, and Past-President of the Foundry Mutual Benefit Association.

The Wear of Cast Iron.

(*Concluded from page* 216.)

1.5 per cent. Mo. It is also claimed that Bermanger iron containing vanadium and titanium offers superior resistance over ordinary cast iron for Diesel cylinder liners in motor ships. A low silicon content or molybdenum addition is generally used in brake block material to achieve higher combined carbon. Fig. 2 is such a low silicon iron and shows free cementite in the phosphide eutectic. Further wear resistance may have been obtained by refining the pearlite with alloy additions or quicker cooling.

Initial surface condition is also thought to play an important part in the wearing of cast iron, and it is thought that rough machining tends to break up the phosphide eutectic and so destroy the bearing metal action in the initial stages of the wear. It has been shown by Klingenstein that in the case of pearlitic irons preliminary surface polishing with 000 emery paper considerably delayed the setting in of wear. Surface treatment did not appear to affect the wear in the case of the ferritic irons. The contradictory nature of the data submitted does at any rate show the complicated nature of wear problems and will give an insight into the aspects that have been touched. The easiest solution to the problem seems to be the continuation of specialised wear testing, that is testing iron under the actual service conditions for which they are intended. Then only will the results be of any immediate practical value.

Messrs. Harry Stephenson & Sons, Limited, iron and steel merchants, etc., announce that their address is now Hindley, near Wigan.

This Week's News in Brief.

Trade Talk.

Messrs. Harris & Pearson, Fire Clay and Brick Works, Stourbridge, have converted their business into a limited liability company.

The Guisborough (Yorkshire) Assessment Committee has agreed to reduce the assessment of the Redcar Ironworks of Messrs. Dorman, Long & Company, Limited, from £20,000 to £15,000, owing to the prolonged depression in trade.

The partnership carried on by Messrs. S. C. Simmons and A. H. Burrows, under the style of Simmons & Burrows, at Cherry Street, Wolverhampton, as general engineers and brass casters, has been dissolved by mutual consent.

The Cunarder "Berengaria's" 55-ton rudder arrived at the works of the Darlington Forge, Limited, on March 28, for repairs. The rudder was brought from Southampton on a ten-wheel lorry, the journey occupying six days and 16 hours.

The Burntisland Shipbuilding Company, Limited, has launched the coasting steamer "Linwood," built for the Joseph Constantine Steamship Line, Limited, of Middlesbrough. The vessel has a deadweight capacity of 1,350 tons, and three holds served by large self-trimming hatchways.

The Irish Free State Executive Council recently imposed an emergency tariff of 33⅓ per cent. on agricultural machinery coming into the country as from midnight on Good Friday. The tariff under the preference scheme so far as Great Britain, Northern Ireland and the Dominions are concerned is 25 per cent.

The joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board have been informed by the accountant that an examination of the employers' books for January and February, 1932, gives an average net selling price of £9 19s. 7.54d. This means that there will be a decrease of 2½ per cent. in basis rates in the wages of the workmen.

The M.V. "C" alloy of Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, has been utilised in the manufacture of food products, road markers, tabulating machines, lubricators, bootmakers' lasts, greyhound-racing equipment, printing machinery, electric shears, trawler floodlights, motor-car parts, tramway equipment, aeroplane components, and in many other industries.

The British Cast Iron Research Association announces that its headquarters offices and laboratories are now situated at 21 to 23, St. Paul's Square, Birmingham. These premises are next door to and more convenient than those hitherto occupied. The telephone number and telegraphic address are unchanged. As hitherto, members will be welcomed at any time in ordinary business hours for the purpose of discussing any matters of interest or to use the library.

Messages from Berlin report the taking of a drastic measure to check the migration of German industry to Britain. It is stated that at the present moment about 200 plants for transfer to German factories in England are in process of dismantling. By a decree, which is already in force, an export duty of 8 mks. a kilogram (about 3s. 6d. a lb.) is laid on used productive machinery leaving Germany. The duty at present applies to productive machines used in the textile, metal and wood-work industries. News that the German Government had obtained powers to impose export duties was contained in a note published under this heading on March 18.

The directors of the London Iron and Steel Exchange have had under consideration a suggestion that a Legal Inquiry Department should be set up for the benefit of members of the Exchange. It is pointed out that it is frequently desirable to obtain legal advice upon points which arise in business, and that members would welcome a scheme which would enable them to obtain this at the cost of a moderate annual subscription. The scheme would enable members to obtain legal advice upon matters arising in their business of iron, steel or metal manufacturers, merchants or dealers, by submitting them to the Exchange. Legal advice to members would include the perusal of papers, consideration of authorities and the writing of opinions. It would not include the drafting of documents, nor the conduct of litigation. Members are being asked to inform the secretary of the Exchange of their views concerning the proposal.

Company Reports.

Vickers-Armstrongs, Limited.—Profit, £282,244; brought in, £60,416; "A" preference dividend, £266,868; carried forward, £75,792.

Partington Steel & Iron Company, Limited.—The profit and loss account shows that there was a net loss for 1931 of £21,396, which has been carried forward.

Hadfields, Limited.—Profit, £23,171; brought in, £62,202; fees, £2,225; debenture interest, £57,152; no dividend on the preference or ordinary shares; carried forward, £25,996.

G. D. Peters & Company, Limited.—Net profit, £3,513; brought in, £15,254; previously reserved for income tax and not now required, £1,783; to reserve, £9,087; provision for exchange losses, £2,325; carried forward, £9,137.

Vickers, Limited.—Profit, £943,811; brought in, £231,970; income tax, £185,192; debenture interest, £172,500; fees, etc., £11,626; preference dividends, £418,190; ordinary dividend of 5 per cent., £153,944; carried forward, £234,329.

Parkinson Stove Company, Limited.—The directors have decided to postpone decision as to the payment of the half-yearly dividend on the 7 per cent. cumulative preference shares, due March 31, until results for the year are known.

Lancashire Steel Corporation, Limited.—Net earnings, subject to depreciation, £53,367; brought in, £3,913; balance of preliminary expenses written off, £23,779; commission for guaranteeing subscription of first preference shares, £31,250; carried forward, £2,250.

British Insulated Cables, Limited.—Profit, £589,611; brought in, £279,317; available, £868,928; fees, etc., £16,170; debenture interest, £35,000; depreciation, £100,000; to reserve, £120,000; preference dividend, £57,500; ordinary dividend of 15 per cent., £250,000; carried forward, £290,258.

Edgar Allen & Company, Limited.—The directors announce that after consideration of the results of the year's trading and the general uncertainty of trade conditions, they are of the opinion that it is still necessary to conserve the company's financial resources. Payment of the dividend on the cumulative preference shares in respect of the half-year ending March 31, 1932, will therefore be deferred.

Steel Company of Canada, Limited.—Manufacturing profit, $2,058,654; interest and income from securities and investments, $365,818; gross profit, $2,424,472; net profit available for dividends, $598,549. Having regard to conservative distribution of earnings during previous years, directors felt justified in paying usual dividends on ordinary shares throughout year, although not fully earned. This has involved deficit of $661,191, which has been drawn from accumulated surplus.

Morgan Crucible Company, Limited.—Trading profit, £145,988; U.S.A. Customs duties refunded and provision therefore not required, £65,224; interest on investments, etc., £35,749; brought in, £561; directors' fees, £3,000; interest on employees' loan obligations, £2,748; preference and preferred dividends, £41,625; interest on 7 per cent. obligations, £13,063; interim dividend on deferred shares, £30,634; income-tax, £47,869; to capitalisation of 7 per cent. obligations, £67,437; final deferred dividend of 6d. per share, £40,462; carried forward, £633.

Contracts Open.

Cairo, April 23.—Centrifugal pumps, motors, switchgear, etc., for the Ministry of Public Works, Egypt (Mechanical and Electrical Department). The Department of Overseas Trade. (Reference G.X. 11,276.)

Edinburgh, April 14.—550 tons of cast-iron pipes, 3-in. to 12-in. dia., for the Corporation Water Department. Messrs. J. & A. Leslie & Reid, 29, Waterloo Place, Edinburgh.

Johannesburg, May 23.—Steel axles, tyres and wheel centres, for the South African Railways and Harbours Board. The Department of Overseas Trade. (Reference G.X. 11,326.)

Rochdale, April 12.—30-ton weighbridge, for the Town Council. The Borough Surveyor, Town Hall, Rochdale.

Personal.

Prof. D. A. Low, Emeritus Professor of Engineering, East London College, has been elected President of the Whitworth Society for the ensuing year, to take office next July at the summer meeting, which is to be held in Birmingham.

Lt.-Col. H. K. Stephenson, J.P., chairman of Messrs. Thos. Turton & Sons, Limited, and a director of the Dinnington Main Coal Company, Limited, and the Sheepbridge Coal & Iron Company, Limited, has been appointed Sheriff for Derbyshire.

Mr. Myron C. Taylor, director and chairman of the Finance Committee of the United States Steel Corporation, has been elected chairman of the board in succession to Mr. J. P. Morgan. Mr. Taylor, who is 58 years of age, in addition to his connection with the United States Steel Corporation, is prominently associated with several leading financial, commercial and public-utility undertakings.

Sir Newton Moore, M.P. for Richmond, Surrey, who has accepted the presidency of the Dominion Steel & Coal Corporation, Limited, of Canada, has applied for the Chiltern Hundreds. His new appointment will require him to spend a considerable amount of time in Canada. Sir Newton Moore was twice Prime Minister of Western Australia before entering the British Parliament in 1918.

Mr. Frank Russell, F.G.S., managing director of General Refractories, Limited, last week lectured on the subject of refractories to the members of the Lincolnshire Iron and Steel Institute. Mr. R. E. Westwood, J.P., presided. Mr. Russell, who has travelled extensively, reviewed this industry in many countries, and concluded that most British manufacturers were handicapped by lack of capital necessary for the installation of better machinery, a condition available to both the German and American manufacturers of refractories.

Wills.

Smith, John, of Ayr, ironfounder ...	£8,236
Coghlan, J. H., of Harrogate, retired iron and steel manufacturer	£85,997

Obituary.

Sir William Graham, a leading figure in the shipbuilding industry in South Wales, died last Saturday, at the age of 70 years He was chairman of the Tubal Cain Foundry & Engineering Works at Cardiff.

Mr. Albert Davidson, of Messrs. Hattersley & Davidson, Limited, engineers, of Sheffield, died on March 24, aged 63. He was also a director of the Heeley Silver Rolling & Wire Mills, Limited, and the Vololo Corrugated Steel Cask Company, Limited.

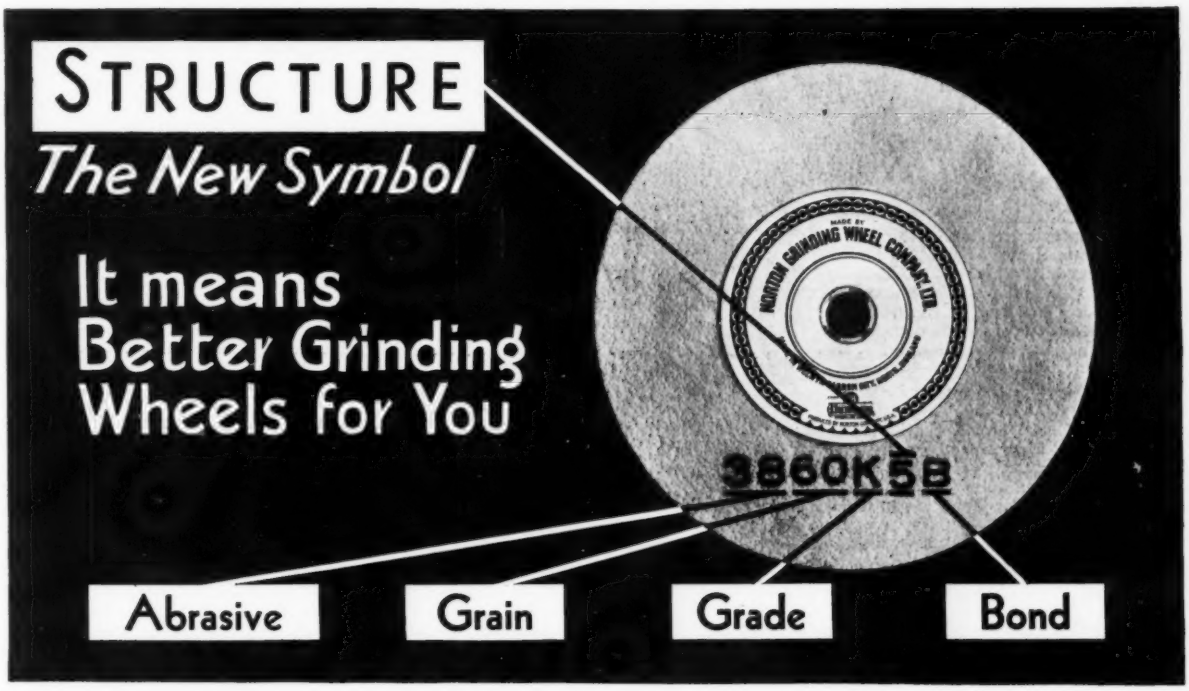
Mr. Arthur Gameson, chairman of directors of Messrs. Thos. Gameson & Sons, Limited, malleable ironfounders, of Walsall, died on March 24. He was an ex-member of the Walsall Town Council, and had been living, owing to failing health, at Colwyn Bay, for some years.

It is with sincere and personal regret that we announce the death of Mr. T. H. Watson, chairman of Messrs. Watsons (Metallurgists), Limited, of Lancaster Street, Sheffield. There are few business men in Sheffield who were better known or more highly respected than the deceased gentleman.

Mr. Robert P. Doxford, who retired in 1912 from the position of managing director of the engineering department of Messrs. William Doxford & Sons, Limited, shipbuilders, Sunderland, has died at his home in Sussex, aged 81. Although he retired 20 years ago, Mr. Doxford had still interested himself in the affairs of the firm.

Mr. Joseph Brass, who for many years held the position of works manager with Messrs. Barclay, Curle & Company, Limited, Whiteinch, Glasgow, died at his home at Prestwick, on March 24. A native of Orkney, Mr. Brass went to Glasgow in 1882 and served his apprenticeship with the Whiteinch firm. He spent a few years at sea and obtained a chief engineer's certificate, afterwards taking up the position of foreman engineer with Messrs. Barclay, Curle & Company. Later he succeeded to the position of works manager, and this he held until his retirement early last year.

HERBERT



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SELLING REPRESENTATIVES
ALFRED HERBERT LTD. COVENTRY.

LONDON, GLASGOW, BIRMINGHAM, MANCHESTER, SHEFFIELD, BRISTOL, NEWCASTLE.

Raw Material Markets.

Business has been quiet in the iron and steel markets during the past week, the influence of holiday conditions still being felt. Orders taken for pig-iron are still only of small dimensions, but a more hopeful atmosphere is present. In the steel market increased Continental competition has been experienced since the appreciation of the pound sterling, and prices are very low. Inquiries have not been very numerous as yet, but the progress of the month should see the usual seasonal increase in the demand.

Pig-Iron.

MIDDLESBROUGH.—Shipments from the Tees have lately shown an improvement, and better sales of Cleveland iron in Scotland are reported to be in sight. On the other hand, there is little demand from local consumers, most of whom are buying only small quantities for immediate delivery, three months' contracts being seldom heard of nowadays. Official quotations are unchanged as follow:—No. 1 Cleveland foundry iron, 61s.; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

Some substantial sales of East Coast hematite have been made to South Wales consumers, and the market has been noticeably strengthened. Mixed numbers can seldom be obtained below 63s. 6d., and more is being paid in some cases. Exports continue to be on a very limited scale. On the West Coast new business has been dull during the past week or so. Fortunately, owing to increased activity at the steelworks, the output of the furnaces in blast is being fairly well absorbed. Bessemer mixed numbers remain at 66s. per ton.

LANCASHIRE.—Several forward contracts for foundry iron have been booked during the past week, and more agreements will soon be coming to an end. Deliveries to consumers have not yet returned to their normal level. Quotations are unaltered, with Midland brands of No. 3 pig-iron—Staffordshire and Derbyshire makes—at 67s. per ton, North-East Coast iron at around 67s., Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish brands of No. 3 at from 86s. 6d. to 87s., West Coast hematite at 81s., and Indian iron at about 77s. per ton; including delivery to Manchester or equal distance.

MIDLANDS.—Many iron foundries in this district were closed last week and trade is still quiet. A meeting of the Central Pig-iron Producers' Association was held in Birmingham last Thursday, but no change in prices was made, so that they remain at 62s. 6d. for Northants No. 3 and 66s. for North Staffordshire, Derbyshire and Lincolnshire No. 3, including delivery to Birmingham and Black Country stations or sidings. Forge pig-iron meets with a very slow sale, and prices are 5s. per ton below those of foundry irons.

SCOTLAND.—Business is slack, and prices are unchanged, with No. 3 foundry at 69s. 6d. f.o.t. furnaces and No. 1 at 72s. per ton. No. 3 Middlesbrough is slow at 58s. 6d. f.o.t. Grangemouth, with other English makes slightly less. Indian basic iron continues to arrive in large quantities, but Continental material is practically off the market. Business has really been too small to test prices fully.

Coke.

The coke market in the Midlands remains quiet. Most consumers are well stocked and present buying only concerns small quantities for early delivery. Best Durham coke is quoted at 37s. 6d. per ton and upwards for good grades, with other qualities at 2s. 6d. less, while Welsh cokes range from 30s. to 45s., according to analysis, delivered Birmingham and district.

Steel.

Orders for finished steel continue to be scarce, in spite of the encouraging volume of inquiries recently circulating. The position of the shipbuilding industry shows little improvement. Small steel bars continue to arrive from the Continent, being quoted at a very low level. Keen competition from abroad is similarly weakening other steel markets. Little business is being done in Continental semis, owing to the vagaries of the exchange, and the existence of pre-tariff stocks in this country. Slightly more business has been going to the home manufacturers.

Scrap.

In the Cleveland scrap-iron market, there is only a weak demand for foundry material. Heavy scrap is offered at 40s. per ton and machinery quality at 42s. 6d. Light castings are not worth more than 35s. per ton. The Midlands market is similarly slack. Good heavy machinery scrap, broken into cupola sizes, is offered at 47s. 6d. per ton delivered, ordinary heavy metal at 42s. 6d. and light metal at 37s. 6d. to 40s. per ton delivered. The foundries in Scotland continue short of work, and are not disposed to buy more material. Prices are weak and mostly nominal.

Metals.

Copper.—The standard market has shown renewed weakness, and last week's gold prices touched a new low level. Unstable conditions continue to prevail, owing to the slackness of consumption, both in Europe and the U.S.A. The restriction of production to 20 per cent. of capacity seems to have had little effect upon the situation, and a complete stoppage of the mines is being demanded in some quarters. The official Exporters' quotation remains at 6.25 cents per lb. c.i.f. Europe. A little copper from an outside source has been offered at a slightly lower level.

Closing quotations :—

Cash.—Thursday, £30 17s. 6d. to £30 18s. 9d.; Friday, £29 15s. to £29 17s. 6d.; Monday, £30 7s. 6d. to £30 8s. 9d.; Tuesday, £30 10s. to £30 11s. 3d.; Wednesday, £30 2s. 6d. to £30 5s.

Three Months.—Thursday, £31 to £31 2s. 6d.; Friday, £30 to £30 2s. 6d.; Monday, £30 11s. 3d. to £30 12s. 6d.; Tuesday, £30 8s. 9d. to £30 10s.; Wednesday, £30 to £30 2s. 6d.

Tin.—After a bad fall, standard tin rose again on Friday by £6, and the market has taken on a firmer appearance. The panic was mostly due to heavy selling by Continental speculators. Consumption remains low, while the March statistics reveal a small increase in the total visible supplies. The only bull point at the moment is the lowness of consumers' stocks, on both sides of the Atlantic, and heavier buying seems predicted once the present depression is past. Up to now, however, there has been no departure from hand-to-mouth buying.

Official closing prices :—

Cash.—Thursday, £114 to £114 5s.; Friday, £106 12s. 6d. to £106 17s. 6d.; Monday, £111 2s. 6d. to £111 5s.; Tuesday, £109 to £109 2s. 6d.; Wednesday, £108 10s. to £108 12s. 6d.

Three Months.—Thursday, £115 15s. to £116; Friday, £108 5s. to £108 10s.; Monday, £113 to £113 5s.; Tuesday, £111 to £111 5s.; Wednesday, £110 12s. 6d. to £110 15s.

Spelter.—Owing to the rise in sterling, there was a considerable fall in prices last week. Some buying by consumers was witnessed at the lower levels, and the market is now steadier. Messrs. Rudolf Wolff & Company say that: "On the Continent, the market remains quiet without very definite tendency, and trade demand continues on a low scale, but holders display no anxiety to liquidate their stocks at current prices."

Daily fluctuations :—

Ordinary.—Thursday, £11 5s.; Friday, £10 15s.; Monday, £11 2s. 6d.; Tuesday, £10 17s. 6d.; Wednesday, £10 11s. 3d.

Lead.—On Friday the gold value of lead fell to a record low level, well below the former low price of £9 per ton reached in 1894. Since then there has been a slight recovery in sentiment and the position is somewhat stronger. It is impossible, however, to overlook the generally poor state of consumption, both here and on the Continent.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11 2s. 6d.; Friday, £9 17s. 6d.; Monday, £11 2s. 6d.; Tuesday, £11 1s. 3d.; Wednesday, £10 16s. 3d.

Cast Irons with Higher Nickel Additions.

(*Concluded from page* 218.)

alloy material with the iron charge through the cupola. For more rigid control it is, however, suggested that crucible or open-hearth furnace melting is to be preferred. Special forms of pig-iron, containing high proportions of nickel and copper, can be used for making up the iron, whilst chromium can be controlled by the use of the cheapest grade of ferro-chrome, the high carbon in such a grade assisting both in crushing the ferro-chromium to the desired degree of fineness, and, at the same time, lowering its melting point so that it alloys the more readily with the iron.

In casting the alloys it is generally found desirable to apply aluminium foundry practice in making allowance for pattern shrinkage and in estimating the size and position of heads, risers, etc. As made up in the ordinary cupola the alloy is sufficiently fluid for all foundry purposes.

Subject to the control of composition, as mentioned above, the austenitic cast irons are readily machinable at ordinary cast-iron speeds. As a check on the structure of the metal, it is worth while remembering that, with most of the alloys, they are non-magnetic when the composition is right, so that the use of a magnet in the foundry will often give a rapid test to check composition.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
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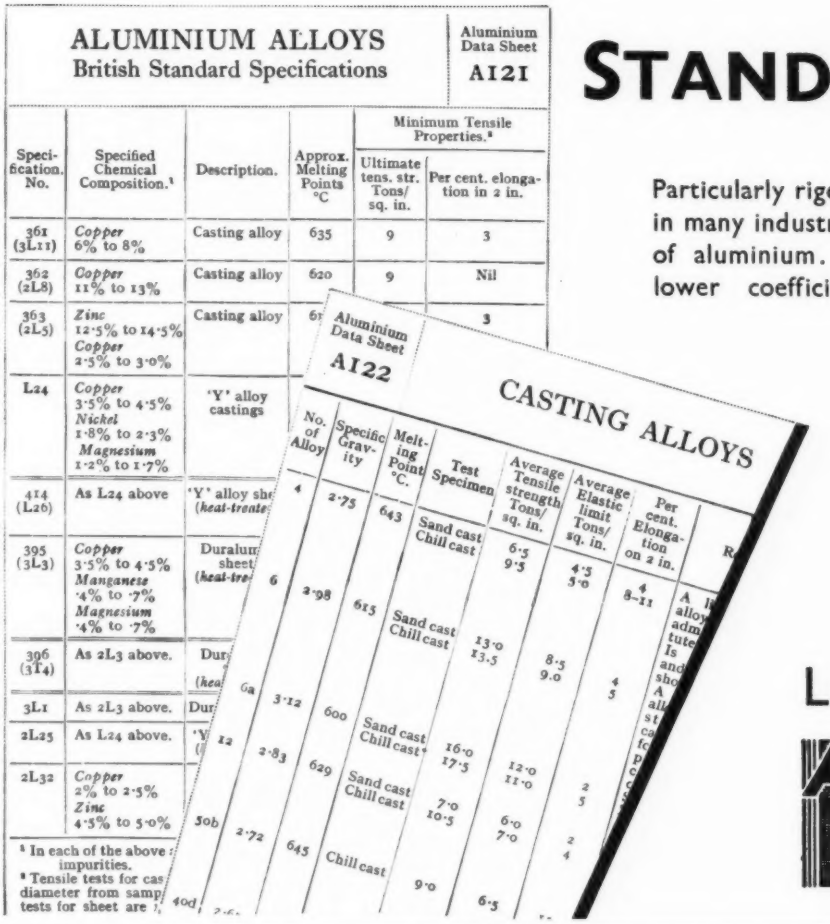

ALUMINIUM ALLOYS
British Standard Specifications

Aluminium Data Sheet A121

Specification No.	Specified Chemical Composition.[1]	Description.	Approx. Melting Points °C	Minimum Tensile Properties.[2] Ultimate tens. str. Tons/sq. in.	Per cent. elongation in 2 in.
361 (3L11)	*Copper* 6% to 8%	Casting alloy	635	9	3
362 (2L8)	*Copper* 11% to 13%	Casting alloy	620	9	Nil
363 (2L5)	*Zinc* 12·5% to 14·5% *Copper* 2·5% to 3·0%	Casting alloy	6[illegible]	[illegible]	3
L24	*Copper* 3·5% to 4·5% *Nickel* 1·8% to 2·3% *Magnesium* 1·2% to 1·7%	'Y' alloy castings			
414 (L26)	As L24 above	'Y' alloy sh[illegible] (*heat-treate*			
395 (3L3)	*Copper* 3·5% to 4·5% *Manganese* ·4% to ·7% *Magnesium* ·4% to ·7%	Duralum[illegible] sheet (*heat-tre*			
396 (3L4)	As 2L3 above.	Dur[illegible] (*hea*			
3L1	As 2L3 above.	Dur[illegible]			
2L25	As L24 above.	'Y[illegible]			
2L32	*Copper* 2% to 2·5% *Zinc* 4·5% to 5·0%				

[1] In each of the above impurities.
[2] Tensile tests for cas diameter from samp tests for sheet are

Aluminium Data Sheet A122

CASTING ALLOYS

No. of Alloy	Specific Gravity	Melting Point °C.	Test Specimen	Average Tensile strength Tons/sq. in.	Average Elastic limit Tons/sq. in.	Per cent. Elongation on 2 in.	R
4	2·75	643	Sand cast	6·5	4·5	4	A
			Chill cast	9·5	5·0	8–11	
6	2·98	615	Sand cast	13·0	8·5	4	
			Chill cast	13·5	9·0	5	
6a	3·12	600	Sand cast	16·0	12·0	2	
			Chill cast[1]	17·5	11·0	5	
12	2·83	629	Sand cast	7·0	6·0	2	
			Chill cast	10·5	7·0	4	
50b	2·72	645	Chill cast	9·0	6·5		
40d							

STANDARD ALLOYS

Particularly rigorous conditions of service have been met in many industries by the development of new light alloys of aluminium. High tensile strength, fatigue resistance, lower coefficient of expansion, corrosion resistance and other special qualities have been secured in this way. These developments have kept step with the increasing use of the older alloys, which are still standard practice for the great majority of aluminium alloy applications.

Suitable data sheets will be sent on request.

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For removal of Dust, Steam or Fumes + Ventilation of Buildings, Mines & Ships + Mechanical Boiler Draught + Cooling & Drying + Air Conditioning + Pneumatic Conveying.

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DUST COLLECTORS for Chimney Gases and general Industrial purposes.

AIR WASHERS + AIR HEATERS (Steam or Direct Fired) Steam Turbine Heater Units.

DAVIDSON & CO., LIMITED.

Sirocco Engineering Works, Belfast.

LONDON, MANCHESTER, BIRMINGHAM, NEWCASTLE, CARDIFF, BRISTOL, GLASGOW.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	30	2	6
Three months	30	0	0
Electrolytic	34	10	0
Tough	32	10	0
Best selected	33	0	0
Sheets	66	0	0
India	44	10	0
Wire bars	37	0	0
Do., May	36	0	0
Do., June	35	0	0
Ingot bars	36	0	0
H.C. wire rods	39	10	0
Off. av. cash, Mar.	33	1	9 1/16
Do., 3 mths., Mar.	33	6	2½
Do., Sttlmnt., Mar.	33	1	10½
Do., Electro, Mar.	37	5	1½
Do., B.S., Mar.	36	10	3½
Do., wire bars, Mar.	37	14	6½
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6¾d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£	s.	d.
Standard cash	108	10	0
Three months	110	12	6
English	109	15	0
Bars	112	5	0
Straits	112	15	0
Australian	110	10	0
Eastern	114	10	0
Banca (nom.)	118	0	0
Off. av. cash, Mar.	129	18	2½
Do., 3 mths., Mar.	131	12	6½
Do., Sttlmt., Mar.	129	17	10½

SPELTER.

	£	s.	d.
Ordinary	10	11	3
Remelted	9	15	0
Hard	9	15	0
Electro 99.9	13	7	6
English	11	15	0
India	11	5	0
Zinc dust	22	0	0
Zinc ashes	2	10	0
Off. aver., Mar.	12	16	4 1/16
Aver. spot, Mar.	12	12	3½

LEAD.

	£	s.	d.
Soft foreign ppt.	10	16	3
English	13	0	0
Off. average, Mar.	12	9	9½
Average spot, Mar.	12	6	10½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	0	0
Do., V.M. ex-whf.	20	5	0
Rods	27	0	0
Boiler plates			—
Battery plates			—

ANTIMONY.

	£	s.	d.
Special brand Eng.	40	0	0
Chinese	27	0	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	17	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—

25%	£7 5 0
45/50%	£12 15 0
75%	£17 12 6

Ferro-vanadium—

35/50%	12/8 lb. Va.

Ferro-molybdenum—
70/75% c. free, 4/2, plus 55%, per lb. of Mo.

Ferro-titanium—
23/25% carbon-free .. 10½d. lb.

Ferro-phosphorus, 20/25% .. £20 17 6

Ferro-tungsten—
80/85% .. 1/8½ lb. plus 20%

Tungsten metal powder—
98/99% .. 1/11½ lb. plus 20%

Ferro-chrome—

2/4% car.	£27 15 0
4/6% car.	£24 17 6
6/8% car.	£24 0 0
8/10% car.	£23 15 0

Ferro-chrome—

Max. 2% car.	£38 17 6
Max. 1% car.	£45 0 0
Max. 0.70% car.	£55 10 0
70% carbon-free	1/2½ lb.

Nickel—80/99.5% .. £220 to £225

"F" nickel shot .. £212 10 0

Ferro-cobalt .. 9/3 lb.

Aluminium 98/99% .. £95 0 0

Metallic chromium—
96/98% .. 3/- lb.

Ferro-manganese (net)—

76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 0 0

Metallic manganese—
94/96% carbon-free .. 1/7 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over .. .. 4d. lb.
Rounds and squares, under ½ in. to ¼ in. .. .. 3d. lb.
Do., under ¼ in. to 1/16 in. .. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in. .. .. 3d. lb.
Do., under ¼ in. × ¼ in. .. 1/- lb.
Bevels of approved sizes and sections .. .. 6d. lb.
Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	5	0 to	2	7	6
Bundled steel and shrngs.	1	17	0 to	1	18	0
Mixed iron and steel	2	0	0 to	2	2	0
Heavy cast iron				2	6	0
Good machinery for foundries				2	10	0
Cleveland—						
Heavy steel				1	15	0
Steel turnings				1	12	6
Cast-iron borings				1	6	0
Heavy forge				2	15	0
W.I. piling scrap				2	7	6
Cast-iron scrap	2	0	0 to	2	2	6
Midlands—						
Light cast-iron scrap				1	17	6
Heavy wrought iron				2	12	6
Steel turnings, f.o.r.				1	0	0
Scotland—						
Heavy steel				1	17	6
Ordinary cast iron				2	7	6
Engineers' turnings				1	9	6
Cast-iron borings				1	11	0
Wrought-iron piling				2	5	0
Heavy machinery				2	12	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	27	0	0
Brass	19	0	0
Lead (less usual draft)	9	0	0
Tea lead	6	0	0
Zinc	5	0	0
New aluminium cuttings	72	0	0
Braziery copper	24	0	0
Gunmetal	21	0	0
Hollow pewter	70	0	0
Shaped black pewter	50	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—

Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	64/-
Hematite M/Nos.	63/6

N.W. Coast—

Hem. M/Nos. d/d Glas.	72/6
„ d/d Birm.	84/6
Malleable iron d/d Birm.	117/6

Midlands—

Staffs common*	—
„ No. 4 forge*	61/-
„ No. 3 fdry.*	66/-
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	57/6
„ fdry. No. 3*	62/6
„ fdry. No. 1*	65/6
Derbyshire forge*	61/-
„ fdry. No. 3*	66/-
„ fdry. No. 1*	69/-
„ basic*	—

*d/d Black Country dist.

Scotland—

Foundry No. 1	72/-
„ No. 3	69/6
Hem. M/Nos. d/d	68/6

Sheffield (d/d district)—

Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	74/6
W.C. hematite	83/6

Lancashire (d/d eq. Man.)—

Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	86/6 to 87/-
Clyde, No. 3	86/6 to 87/-
Monkland, No. 3	86/6 to 87/-
Summerlee, No. 3	86/6 to 87/-
Eglinton, No. 3	86/6 to 87/-
Gartsherrie, No. 3	86/6 to 87/-
Shotts, No. 3	86/6 to 87/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	15	0 to	10	0	0
Nut and bolt iron	8	7	6 to	8	10	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	2	6
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	10	0 to	9	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)	6	12	6 & up.			
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)				9	10	0
Black sheets, 24g.	8	0	0 to	8	10	0
Galv. cor. shts.	9	10	0 to	10	0	0
Galv. flat shts.	10	0	0 to	11	0	0
Galv. fencing wire, 8g. plain				12	10	0
Billets, soft	5	5	0 to	5	10	0
Billets, hard				6	12	6
Sheet bars	4	15	0 to	5	5	0
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12d.
Rods	11½d.
Tubes	16½d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	15.64
No. 2 foundry, Valley	15.00
No. 2 foundry, Birm.	11.00
Basic	16.39
Bessemer	17.39
Malleable	17.39
Grey forge	16.89
Ferro-mang. 80%, seaboard	75.00
O.-h. rails, h'y, at mill	43.00
Billets	27.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	2.11
Steel bars	1.50
Tank plates	1.50
Beams, etc.	1.50
Skelp, grooved steel	1.50
Skelp, sheared steel	1.50
Steel hoops	1.65
Sheets, black, No. 24	2.20
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	22/6 to 27/6
„ furnace	17/6 to 18/-
Durham and Northumberland—	
„ foundry	14/6 to 15/-
„ furnace	13/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	16/-
„ 28×20 „	32/-
„ 20×10 „	23/-
„ 18⅞×14 „	16/7½
C.W. 20×14 „	14/-
„ 28×20 „	30/-
„ 20×10 „	19/10
„ 18⅞×14 „	15/-

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0 to	£7	0	0
Bars, hammered, basis	£16	10	0 to	£17	0	0
Bars and nail-rods, rolled, basis	£15	17	6 to	£16	5	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	65%	57½%
Water ..	61½%	52½%
Steam ..	57½%	47½%

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Mar.	31 ..	30	17	6	dec. 15/-
Apr.	1 ..	29	15	0	„ 22/6
„	4 ..	30	7	6	inc. 12/6
„	5 ..	30	10	0	„ 2/6
„	6 ..	30	2	6	dec. 7/6

Electrolytic Copper.

		£	s.	d.	
Mar.	31 ..	34	0	0	dec. 20/-
Apr.	1 ..	33	0	0	„ 20/-
„	4 ..	33	0	0	No change
„	5 ..	34	0	0	inc. 20/-
„	6 ..	34	10	0	„ 10/-

Standard Tin (cash).

		£	s.	d.	
Mar.	31 ..	114	0	0	dec. 130/-
Apr.	1 ..	106	12	6	„ 152/6
„	4 ..	111	2	6	inc. 90/-
„	5 ..	109	0	0	dec. 42/6
„	6 ..	108	10	0	„ 10/-

Tin (English ingots).

		£	s.	d.	
Mar.	31 ..	115	10	0	dec. 135/-
Apr.	1 ..	108	0	0	„ 150/-
„	4 ..	112	10	0	inc. 90/-
„	5 ..	110	5	0	dec. 45/-
„	6 ..	109	15	0	„ 10/-

Zinc Sheets (English).

		£	s.	d.	
Mar.	31 ..	24	0	0	No change
Apr.	1 ..	23	0	0	dec. 20/-
„	4 ..	23	0	0	No change
„	5 ..	23	0	0	„ „
„	6 ..	23	0	0	„ „

Spelter (ordinary).

		£	s.	d.	
Mar.	31 ..	11	5	0	dec. 10/-
Apr.	1 ..	10	15	0	„ 10/-
„	4 ..	11	2	6	inc. 7/6
„	5 ..	10	17	6	dec. 5/-
„	6 ..	10	11	3	„ 6/3

Lead (English).

		£	s.	d.	
Mar.	31 ..	13	0	0	dec. 10/-
Apr.	1 ..	12	0	0	„ 20/-
„	4 ..	13	5	0	inc. 25/-
„	5 ..	13	5	0	No change
„	6 ..	13	0	0	dec. 5/-

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 3	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 8	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58	58 6	58 6	58 7
1932	58 6	58 6	58 6	—	—	—	—	—	—	—	—	—	—

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13, RUMFORD STREET, LIVERPOOL.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

ROLL Foundry MANAGER and METALLURGIST, with over 20 years' experience in technical and administrative control of large foundries, desires change. Successful production of chilled rolls, for hot and cold rolling, alloy C.I. rolls, and high-grade castings, from cupola and air furnace. Would act as consultant.—Box 146, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

YOUNG Foundry FOREMAN desires change to improve position; age 29; iron, bronze, aluminium; first-class references.—Box 142, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN, to take charge of Brass Foundry in the Midlands. Knowledge of drawings and experience essential; Hand and Machine Moulding in dry or green sand, moulding of Brasses and Bronzes and Aluminium Alloys in oil-fired reverberatory furnaces.—Applicants to state salary required, and enclose copies of references, to Box 144, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of The Foundry Trade Journal.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

EXPERIENCED and well-known Foundry Manager is open to consider new engagement. Has had complete control of large foundries engaged in all branches of ironfoundry work, from small repetition work to castings of 50 tons. (168)

FOUNDRY Manager seeks re-engagement; 25 years' first-class experience on highest-class iron and brass castings, including pumps, cranes, and repetition work. Good technical knowledge. Age 49. (169)

PUBLICATION.

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1932 edition. Now ready. Price 42s., bound in cloth.—Industrial Newspapers, Ltd., 49, Wellington Street, Strand, London, W.C.2.

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145,000 Sq. Ft. of Shops.

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Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

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ALBION WORKS, SHEFFIELD.

MACHINERY.

"BRISTOL" Air Compressor, capacity 44 c.f. per min., with fast and loose pulley, also Automatic Air Unloader and Riveted Air Receiver, 5 ft. 0 in. x 2 ft. 0 in. dia., with safety valve, etc. Pneumatic Rammer and "Coleman" Plain Jar Ramming Machine, with table about 15 in. x 20 in. All new August, 1931. Used 5 hrs. Cost £115. What offers?—Apply, Box 138, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

NEARLY new Sandblast Room Plant; 8-ft. sq. room, V2 separator and cyclone, vertical compressor, fan and usual equipment; installed 1931, very little used; can be seen working.—Box 140, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WHEEL Moulding Machines. One each 4 ft. 6 in., 5 ft. 0 in. and 6 ft. 0 in. Machines, new, to be sold at much-reduced prices.—Write for particulars, Buckley & Taylor, Limited, Oldham.

THOS. W. WARD, LTD.

130 Cap. Semi-port. Petrol D. Air Compressor.
8-kw. Petrol D. Generating Set, 80 v., 1,300 revs.
Open-ended Bar Shears, for 1½" rods.
"IDEAL" BALL MILL, casing 6' 0" dia.
STONE BREAKERS, 8" to 24" size.
SINGLE and DOUBLE CHAIN GRABS, ½ to 2 cub. yds.
3 LANCS BOILERS, 30' x 8', 150 lbs. press.
STEEL CHIMNEY, 63' high x 5' 6".
DITTO, 70' high x 3' 0".

ALBION WORKS, SHEFFIELD.

"Albion" Catalogue on application.

MISCELLANEOUS.

LINSEED OIL and LINSEED OIL FOOTS. Advertisers have for sale large quantities of these materials at 10 per cent. under to-day's market prices—guaranteed Genuine Linseed Oil and Linseed Oil Foots.—For further particulars and prices write, Box 130, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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[2,200 pages 8½" × 5½"].

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Telephone: Temple Bar 3951 (5 lines).

'Phone: 287 SLOUGH

LADLES—GEARED

12-Ton "Stevenson"	... ...	£48
9-Ton "MacNeil"	... ...	£42
6-Ton "Thwaites"	... ...	£34
4-Ton "Evans"	... ...	£28
2-Ton "Evans"	... ...	£19

PNEUMATIC SQUEEZERS

14"×16" Mumford split pattern 2 @ £35
16" × 16" "Coventry" jolt squeezers ... ... 2 @ £35
14"×16" Tabor split pattern ... 1 @ £35

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PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun, and on occasions—be it admitted—of naughtiness. Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice-Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception. Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

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Here's a suggestion. Your eyesight is worth 3d. a year to you. Send Peter and his handicapped pals 3d. for every year you've had it. Now, please, in case it slips your memory. Good idea?

The Chairman,

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